NAVAL FIGHTERS NUMBER FORTY - FOUR

GRUMMAN'S MACH-2 INTERNATIONAL

F11F-1F SUPERTIGER

BY CORWIN "CORKY" MEYER

EDITORS NOTE

The J79 powered Mach 2 Supertiger derivative of the F-11F was developed into a world class performer and was marketed as such. It impressed the foreign aviators who tested it, so much that it became their first choice. That is until the political-financial giant know as Lockheed wielded it's weight world wide. Lockheed's F-104 eventually dominated world sales, but was never a safe and sane choice as history would prove. Even the fact that the F-104 did not have enough range for the missions it was to perform in foreign hands, was swept aside by Lockheed's persuasiveness.

The Supertiger was an amazing machine with virtually no bad habits. The Tiger struggled to break Mach 1 in level flight, but the Supertiger surprised everyone including the engineers by easily exceeding it's Mach 1.85 design speed and pushing on past Mach 2.

What follows is one of the great stories in aviation history!

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ABOUT THE AUTHOR

Corwin "Corky" Meyer grew up in Springfield, Illinois. He attended the University of Illinois and the Massachusetts Institute of Technology. His test flying career spans 55 years in more than 125 different types of civilian and military aircraft.

Mr. Meyer joined the Grumman Aircraft Engineering Corporation in 1942 as an experimental test pilot. He became project pilot for the following fighters: Hellcat, Tigercat, Bearcat, Panther, Jaguar, Tiger, and the Mach two Super Tiger. He flew many tactical aircraft made throughout the world, including the Japanese Zero and the A-6 Intruder. In 1954, he became the first civilian pilot to qualify aboard the USS Lake Champlain (CVA-39) in Cougars with VF-61. In 1965, he became Director of Aircraft Delivery Operations, and in 1969, he became Senior Vice President of all Manufacturing Operations and Quality Control. In 1974, he was elected President and CEO of Grumman American, a commercial airplane subsidiary.

After retiring in 1978, he became President and CEO of Enstrom Helicopter Corporation, Falcon Jet Corporation, and OMAC with special tasks to realign the operations of these corporations. Mr. Meyer is a Fellow of the Society of Experimental Test Pilots and an Associate Fellow of the American Institute of Astronautics and Aeronautics. He also served as a consultant to the European research organization AGAARD (a NATO Committee for Research and Development) and NASA. Mr. Meyer has a daughter, Sandra Louise, and two sons, John Fyfield and Peter Corwin.

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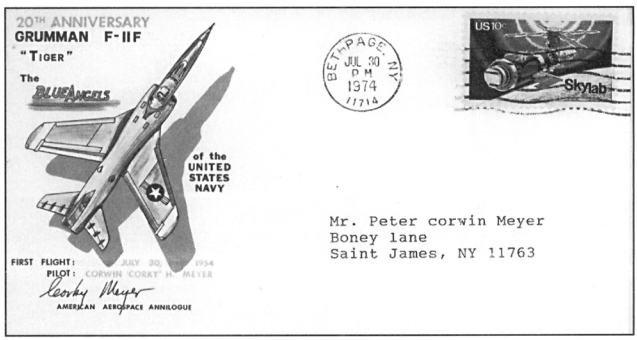
Above, Auther Corwin "Corky" Meyer.

FRONT COVER:

The first prototype F11F-1F Super Tiger, BuNo 138646, fitted with dummy dorsal mounted Sidewinders and folding ventral stabilizing fins as used on Vought's F8U-3 Crusader III on the ramp at Edwards AFB, California. Flight testing and wind-tunnel tests confirmed that these fins were not needed on the Super Tiger. (Grumman

BACK COVER:

Three views of the second prototype, BuNo 138647, in three different paint schemes. The upper photo shows the F11F-1F fitted with a belly Sidewinder dual launcher. The General Electric scheme was the last one used on the Super Tiger. (Grumman)



GRUMMAN'S INTERNATIONAL TIGER, THE F11F-1F SUPERTIGER STORY
BY CORWIN "CORKY" MEYER

Above, the number one Super Tiger at Bethpage, New York, prior to being painted and to the addition of the forward wing sweep fillet as used on the second batch production Tigers. Note the larger reshaped nose, intakes and forward canopy. (Grumman via Corky Meyer)

BACKGROUND:

The Tiger was supposedly designed around a known engine, the Curtiss Wright J65. Half of that story was true. The engine was a known entity but the afterburner was a disaster. It never delivered the specified thrust performance dictated in the contract. Fortunately, there were two teams interested in further Tiger competitive engine development: one at Grumman and one at the Navy Bureau of Aeronautics, each with very different and strong motivation.

The Grumman team knew that Curtiss Wright did not have a great name in jet engine development, and therefore looked at the USAF developed General Electric J73 non-afterburning engine with 8,920 pounds of thrust and presently installed in production North American F-86Hs. They planned to combine that engine with an afterburner and a 45° swept wing to get a truly supersonic Tiger. This was proposed as Grumman designs G98-A and G98-D. This design proposal was turned down by the Navy, possibly because the J73 was not in the Navy inventory.

The Tiger design team was nonetheless dedicated to keeping the Tiger in the forefront; thus the design G98-J was presented to the Navy in January 1955. This GE J79-3A proposal was accepted by the Navy on 18 August 1955. The last two Tigers of the first contract (BuNo 138646 and 138647) were designated to have the GE J79-3A installed replacing the J65-W-18. The two engines were approximately the same length and diameter. The J79 dry weight of 3,250 pounds was 250 pounds lighter than the J65 engine. To show how much GE was ahead of the industry in engine development, especially of Curtiss Wright, the J79 Phase O engine had 2,600 pounds more non-afterburning thrust and 3,750 pounds more afterburning thrust than the J65 in the same sized but much lighter package.

The redesign of the basic fuselage structure was relatively simple. Only the ducts had to be redesigned to accept the greater air flow requirements of the J79.

The Navy approved Grumman's G98-J design for another very good reason. On 18 October 1954, the Navy ordered two prototypes of the F4H-1 Phantom. This new missile armed all-weather fighter was powered by the same General Electric J79-3A as to be used in the G98-J Super Tiger. The Navy purposely wanted to get that engine airborne for some development flight testing in the already developed Tiger before it would fly as a new engine/aircraft combination in the complex twin-engine F4H-1.

Because the Tiger had already shown such good stability and control in dives up to 1.4 Mach, Grumman hoped that the Super Tiger would not require stability augmentation systems to assist our flight controls at the same Mach numbers. Century Series fighters had shown the need for such devices. We did keep the yaw damper in the rudder control similar to most of the other fighters in order to keep the lateral-directional flight characteristics under control in rough air at all Mach numbers.

The G98-J proposal to the Navy predicted high speed level flight to be only 1.3 Mach. The results of my flight tests at Edwards with the first afterburner had shown that the Tiger would have a speed of 1.05 to 1.1 Mach. I was asked by Bob Hall, VP of Experimental, to get a consensus throughout the engineering department as to the top speed of the Super Tiger. Flight tests had shown that 1.1 Mach was the fastest the Tiger had achieved with production J65s with afterburners. We were to find out that the J79 engine would surpass the 1.3

FIRST SUPER TIGER PROTOTYPE FLIGHT ON 25 MAY 1956

Below, the classic Super Tiger pose shows off the coke bottle area rule fuselage and enlarged intakes. When the author was the project pilot, and before the first NPE, he would not allow the wasteful time out of flight testing to take aerial shots of the Super Tiger. On his last flight this picture was taken with two others. He soon knew regret when he was trying to sell this airplane with only three aerial pictures. (Grumman)

Mach estimate by 462mph!

Other than the engine installation, the main difference between the Super Tiger prototypes and the Tiger was an extended and enlarged nose section to house the 24-inch disk of the Westinghouse APQ-50 search radar.

FIRST PROTOTYPE FLIES:

After all the engine problems Grumman experienced with the J65, I as the project pilot had little trouble convincing top management to take this program to Edwards AFB.

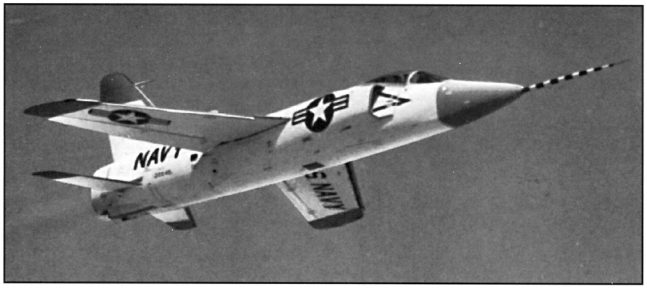
The Super Tiger first flew at Edwards on 25 May 1956, just nine months after the contract was signed. The first flight attempt in BuNo 138646 on 7 May 1956 was a "hot airplane" fiasco. Because of the very high thrust of the main engine of the J79, I had to light the afterburner after I started rolling or I would have skidded the tires and probably blown them. After I started rolling with full military power, I moved the throttle to the left into the A/B detent but nothing happened. I tried it again and again until I was about out of runway. It finally lit and we were off. By that time I finally noticed that the pressurized air coming in the cockpit was up to 140° and was rapidly increasing. I was forced to open the canopy and land immediately. Something was really wrong! The engineering team tried to tell me that such heat was normal in a high powered airplane. I wouldn't buy it because I had flown several of the Century series fighters and their cockpit cooling systems worked great. Using less emotional engineering and better inspection of the system showed that a certain balancing air valve in the pressurization system had been wrongly located in a vented area. Because of a high differential

pressure it could not close. It was relocated and our "hot" airplane cockpit cooled properly. The A/B throttle switch was replaced and we accelerated to Mach 1.2 at 35,000 feet on the second and much more successful flight.

Our flight test priority for the first prototype, which had the same engine intake duct splitter plate as the Tiger, was to determine the optimum full power afterburner climb schedule and high speed level flight Mach number for the J79-A3 Phase O engine installation. The climb schedule finalized as: accelerate to 500mph at sea level, pull up to a 30° climb angle maintaining 500mph until the Mach meter showed .93 Mach and hold that constant until reaching the required altitude. Our actual climb performance showed that the Super Tiger had a rate of climb three times greater than the Tiger. The maximum level flight speed at 35,000 feet was determined to be Mach 1.61, which we attained on the fifth flight, on 5 June 1956. We were especially pleased that the Super Tiger achieved 1.61 Mach during these tests, in contrast to the 1.3 Mach predicted, with very satisfactory stability and control characteristics. Directional stability in other supersonic aircraft usually decreased as the supersonic Mach number increased. Our flight test results at Mach 1.61 showed that we could be confident of a satisfactory

Above, Super Tiger #1, BuNo 138646 at Edwards AFB in its original configuration and paint scheme. The instrument probe was white and red stripes. (Grumman)

Below, Public Relations photo taken during the author's last flight in 138646. Aircraft was over-all white with da-glo red nose, canopy, wing tip and tail stripes. Intake lips and wing and tail leading edges were polished metal. (USAF via Kaston)



Above, Corky makes a high-speed pass across Edwards lake bed in 1956. (USAF) Below, discussion after the first Super Tiger flight with Corky talking in the center. Bob Munch, on the far left, was the administrator of the team at Edwards and John Rowe, standing at Corky's left, was head of maintenance. (Corky Meyer) Bottom, number one Super Tiger during landing rollout on Edwards lake bed. Full span slats and flaps gave the F11F-1F docile take off and landing speeds. (Grumman)

level of stability to Mach 2.0. We looked forward to the arrival of the second prototype with a much better engine air intake duct boundry layer removal system.

SUPER TIGER DEDICATES A NEW RUNWAY AT EDWARDS AFB:

The lake bed was still very wet from the winter rains and was closed to flight. The new base 18,000-foot runway was completed but also not yet in use. Thus, we were forced to use the 8,000 foot runway at the old base. The new runway was very tempting, but because of traffic on a road between the old and the new base which crossed the runway at the mid point, it could not safely be used. I decided to put our radio truck at the intersection for all of our flights so that they could close the runway temporarily if I needed it for an emergency. On the third flight, on 28 May 1956, I had experienced some heavy airplane vibrations in a speed range that I had previously been through several times. I decided to use the new, longer runway for an emergency engine-off landing. I called our truck, the runway was promptly closed, and I landed. I just got back to our office when an upset General Holtoner, Base Commander, called me on the carpet because I had used the runway without Air Force permission. I suggested that I was not as skilled as his pilots, but perhaps he should station one of his Air Police officers with a radio so his pilots would have the same advantage. A short silence ensued when he replied that my idea was so good that it was now his. Simple ideas are sometimes easy to sell. The vibration was caused by an inspection plate that had blown off the airplane. It was repaired easily.

GRUMMAN SOLVES J79 AIR START PROBLEM:

Sometimes even a large company's right hand doesn't know what the left one is doing. To illustrate, two separate departments of GE were trying to determine the correct fuel pressure for air starts in the J79. From the beginning of the indoctrination with the engine we had used 5 psi as the

correct fuel pressure for ground starting and for several flights had perceived no problems. This was the fuel pressure at which the engine delivered to us was set at. During a casual conversation with Roy Prior, the chief test pilot for GE, he mentioned that the two latest crashes of Lockheed F-104s were caused by the inability of the Lockheed test pilots to make air starts with 5 psi fuel pressure.

I asked him what GE flight test had determined from actual air starts to be the correct fuel pressure for air starts. He answered that the correct pressure was 15 psi and added that the GE Service Department didn't agree with them and were still pushing 5 psi. I immediately grounded our aircraft until GE flight test could get a single answer from their top management. Very shortly thereafter I received a call from one of Grumman's vice presidents, who had received a call from a high level GE bigwig. He wanted to know the reason for my impertinent and unwarranted decision.

When I told him the full story he fully agreed with me. He called his GE counterpart back and very soon I received an official decision from GE top management to change the fuel pressure to 15 psi. So did Lockheed. I also was thanked by Roy Prior for solving the issue.

Below, Super Tiger 138646 on landing rollout on the Edwards lake bed. (Grumman)

Above, the first Super Tiger with the Tiger type inlet duct splitter plate. We calculated that this airplane with the wing root fillet, the fuselage aft extension, and the J79-7 engine would have had a level flight speed of Mach 1.77. This was a far cry from the first estimate of high speed of the Super Tiger of Mach 1.3. (Grumman via Corky Meyer)

GRUMMAN/LOCKHEED SPARES ARRANGEMENT:

For our total program we received only one engine for each airplane and no spares. Lockheed had a hangar full of spare engines and detailed spares for their F-104 program. Once, when we had a problem with a fuel control a new one just seemed to appear. One day I asked my shop superintendent where our supply came from. He suggested that I didn't want to know. I got the word. However, one evening after work when we were alone sipping libations, I asked him to enlighten me. Knowing of our zero engine spares, his first chore when he arrived at Edwards was to befriend the head of Lockheed maintenance and also help him with his social life. He did so well in his

SECOND SUPER TIGER BuNo 138647 FLIES, 16 AUGUST 1956

social engineering assistance that the rest was history. His friend was so appreciative that I think we could have traded engines if the need had arisen.

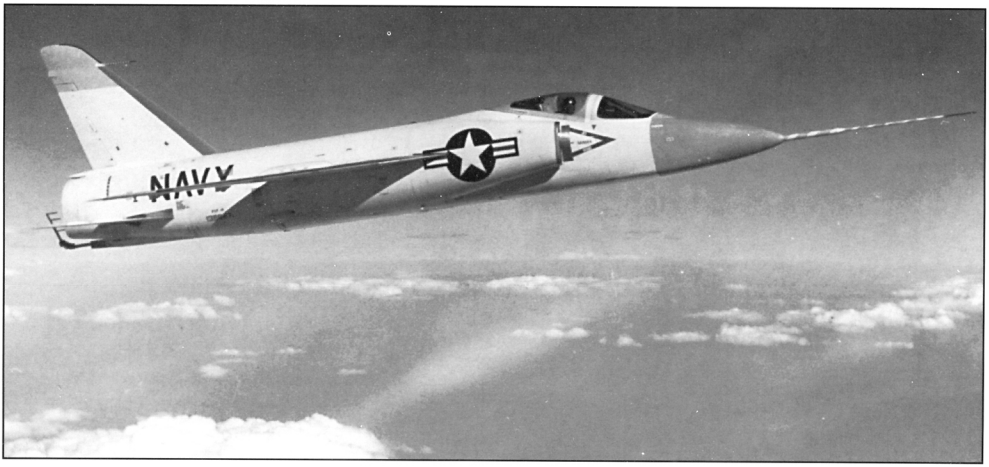
THE SECOND PROTOTYPE FLIES:

The second prototype (BuNo 138647) had the new, untried, but wind tunnel tested bump/suction type ramp method of removing the boundary layer air from the engine air intake duct. We knew from the wind tunnel tests that it would have much better duct efficiency for the engine intake air than the Tiger-type splitter plate of the first prototype. Furthermore, supersonic engine thrust and airplane speed would improve. The new ship also had 60° wing leading edge fillets and a 13.25 inch afterbody extension installed to further reduce supersonic drag.

The second prototype had its first flight on 16 August 1956. We rechecked all of its subsonic and supersonic flight characteristics to Mach 1.61 to be sure that these changes provided no untoward flight characteristics. Finding none, we increased the level flight Mach number to 1.75 Mach, which was still .1 Mach from the limit of our elevator yoke flutter speed envelope. We were happy to find that the 60° wing fillets and the new ducts reduced the supersonic drag much more than predicted. We highly recommended that the fil-

Above, Super Tiger number two in its original configuration and paint scheme on 18 May 1957. Although the paint scheme is identical to the first Super Tiger, the number two ship can be easily identified by its characteristic intake bleed bump. (William Swisher)

Below, the number two Super Tiger in flight on 1 October 1956 with a swinging probe pressure rake that Grumman installed to determine the best aft fuselage contours. (USAF)



lets be installed on the Tiger, but they did not have the same beneficial drag effect, sorry to say. Our flutter speed limit was a torsional weakness at the stabilizer connecting yoke and we had not yet received the mod to fix it. It is interesting to note that we still used the Phase 0 engine, although Lockheed had Phase 1 engines which had more thrust. The predicated directional stability degradation that we expected also did not occur. The yaw damper was also found to have sufficient power for the airplane. We had now proved that the Super Tiger didn't require stability augmentation for any of our three control systems up to 1.85 Mach. We were to be the first and only Mach 2 fighter in the world, before or since, to make this design breakthrough.

Above, compare the initial configuration of the number one Super Tiger with the modifications below which brought it up to standards with the number two Super Tiger in the areas of tailcone design and wing fillets. (USAF via Kaston)

Below, the number one Super Tiger after being retrofitted with the leading edge fillets and the 13.25 inch tailcone extension as originally tested on the number two bird. (via Kaston)

ZOOM CLIMBS:

Zoom climbs were the rage by the other manufacturers of supersonic aircraft, so we decided to try one to see how proficient our Super Tiger was in this maneuver. A zoom climb is performed by getting the most kinetic energy in the airplane by going as fast in flight at as high an altitude as possible, then converting that energy into potential energy by pulling up to a ballastic flight path of 30 to 40 degrees climb angle and letting the airplane climb to the highest point in its trajectory. Obtaining the correct angle of climb was most

Above, CDR George Watkins in a partial pressure suit as used by Corky during his zoom climb. CDR Watkins was the Navy project pilot for the Super Tiger NPE evaluation. (via Corky Meyer)

important for attaining maximum altitude.

To perform any maneuvers above 45,000 feet altitude, the pilot must be equipped with a partial or full pressure suit. These suits looked like fictionalized space suits. They were very clumsy to wear unpressurized and almost impossible to move in when automatically pressurized in case of cockpit pressurization loss. Without such a suit, one would die instantly if the canopy broke and cabin pressurization was lost. They were also very claustrophobic and limited one's vision considerably. I was not looking forward to this flight.

In the zoom trajectory, the afterburner usually flamed out at 65,000 feet. The engine flamed out at higher altitudes and had to be relit when the aircraft descended to its upper relighting limit, usually below 40,000 feet. Speeds at the apogee of zoom climbs fell below 100 mph. The airplane couldn't be maneuvered because it was well below its normal stall speed. At best, it was a difficult maneuver for the pilot and the airplane and useless as a tactical ploy, both because it was difficult to re-aim the aircraft and because there were very few missiles that could operate in that rarified atmosphere. On my first and only zoom climb, I didn't attain the proper climb angle and I only reached 61,500 feet. We considered the flight satisfactory as a system check. I was happy that only the afterburner blew out. I was expecting the engine also to flame out as the J-79 had not made any zoom climbs before my attempt. I tried relighting the A/B as I descended and found that it easily relit on the first attempt at 46,000 feet.

On 27 October 1956, we installed a Phase I J79 engine in the number two prototype. This engine had a 600 pound increase of A/B thrust. I flight-checked it and we found that the airplane accelerated much more rapidly to 1.87 Mach.

NAVY PRELIMINARY EVALUATION AT EDWARDS:

As the Super Tiger had completed its full flutter flight envelope, we immediately invited NATC Patuxent to perform a NPE. We still had high hopes that the Super Tiger's performance would excite Navy fighter procurement personnel.

The following is the complete abstract of the evaluation of CDRs Tom Gallegher Jr., Head of the Flight Test Branch, and George Watkins, Project Pilot. Both of these pilots were associates I had known and flown with for many years.

"Project TED No. PTR AC-22003.1; Navy Preliminary Evaluation of Model F11F-1F airplane, Report No. 1, 28 November 1956.

1.) A Navy Preliminary Evaluation of the model F11F-1F airplane was conducted at Edwards Air Force Base, Mojave, CA, during the period 31 October through 8 November 1956. The evaluation was completed in 23 flights totalling 25.7 flight hours. The

Below, the raw power of a full afterburner run can be seen as Super Tiger number one lights its candle. The Douglas XF4D-1 Skyray in the background was the GE test bed for the J-79. (via Corky Meyer)

purpose of the evaluation was to investigate the flying qualities and engine and airplane performance of the F11F-1F airplane with special emphasis on the airplane performance improvement with the installation of the GE J79-3 higher thrust engine.

2.) Except for the insufficient mission time and within the mission envelope investigated, the general flying qualities at subsonic speed and the exceptional performance with and without afterburner, make the F11F-1F airplane an outstanding day fighter. Present unacceptable items include afterburner light-off and blow-out altitudes, longitudinal trim change associated with flap/slat extension and retraction and insufficient mission time. Unsatisfactory items include aft field of view, magnitude of longitudinal trim change in the transonic region, inadequate stall warning, angle of inclination of the pilot's seat, light rudder forces, lateral sensitivity in configuration PA below 160 knots, longitudinal sensitivity in all clean conditions, buffet boundary below .9 Mach and the complexity of the present engine controls.

3.) It is recommended that all unacceptable items be corrected at the earliest date and that, because of the great potential of the F11F-1F aircraft as a superiority day fighter, a study be made in an effort to increase the mission time to be consistent with current fleet requirements".

The Navy report did not find anything that we couldn't fix. It praised the airplane much more effusively than we had ever seen in other NPE reports. We were sure that we could now change the Navy's mind about the Super Tiger's future procurement.

During this evaluation, CDR Watkins made 5 zoom climbs to 72,500 feet starting at 1.85 Mach and 42,000 feet. That was way beyond the maximum flight envelope we had tested prior to their evaluation.

Although the Navy NPE report had noted 3 unacceptable and 9 unsatisfactory items most were mechanical redesigns and easy to fix. Even mission time could be remedied by installing the production Tiger fin and cheek fuel tanks, bringing the mission time from 46 minutes to an acceptable 1.5 hours. You can well understand that the Navy pilots knew these facts but were not permitted to speculate on future possibilities in their reports. These Navy reported "facts" were to plague our subsequent sales campaign unmercifully.

SUPER TIGER'S SPEED ECLIPSES F8U-1 WORLD SPEED RECORD:

It is interesting to note that the Chance Vought F8U-1 Crusader set an all-out speed record of only 1.58 Mach two weeks after CDR Watkins had flown at 1.85 Mach. This was the airplane that the Navy had decided to purchase in great quantity for the next 10 years. The Super Tiger performance was starting to embarrass some Navy officials and also the Grumman engineers who had predicted a maximum speed of only 1.3 Mach a few months before.

USAF EVALUATION:

Needless to say, the USAF pilots who had chased me and the Navy test pilots in their evaluation put pressure on their leaders at the Air Research and Development Command in Baltimore to evaluate our bird. We prudently encouraged them, knowing the Navy's possible disinterest because of the F8U-1 Crusader procurement.

Twelve flights totalling 10 hours and 50 minutes were flown between the 7th to the 10th of November 1956 by three USAF test pilots. They were Major Stewart Childs, Director of Fighter Test, Captain Ivan Kincheloe, project pilot, and General Stan Holtoner, Base Commander. Their report was as glowing as the Navy's, even though they compared it to the much lighter, smaller, and more agile F-104A, also with the GE J79-3A Phase 0 engine. Their conclusions and recommendations were as follows:

CONCLUSIONS

The Grumman design 98J which was flown under the Navy designation of F11F-1F, can satisfactorily perform the mission of air superiority interceptor or day fighter against aircraft comparable to those presently operational. The favorable characteristics of the aircraft are:

1.) Simplicity of cockpit and aircraft control designs.
2.) Excellent low speed handling characteristics with the exception of oversensitive lateral control and stall warning in the power approach configuration.
3.) Generally desirable stability and control characteristics over the entire speed range of the aircraft. Roll rates decrease with increasing Mach num-

Below, USAF display model with proposed dorsal mounted Sidewinders. (via Craig Kaston)

Below, the number one Super Tiger as tested by the Air Force. A dorsal spline had been added to hold the missile launching parallelogram racks that would have lifted them six feet before they were fired. Wind tunnel tests showed the spline had a negative drag that counteracted the drag of the missiles. The dummy missiles were painted dark blue. (Grumman)

ber such that lateral control is marginal at high Mach numbers. It should be noted that inertia coupling tendencies were not investigated over 1.1 Mach number or during less than one G flight at any speed.

The major deficiencies of the aircraft were:

1.) Low excess thrust which increases acceleration time, time-to-climb, and decreases turning performance.
2.) Present speed restrictions at low altitude caused by the stabilizer yoke flutter limits.

Less serious shortcomings included:

1.) Excessive transonic longitudinal trim change.
2.) Excessive trim change with flap extension and retraction.

RECOMMENDATIONS

Should the design 98J be considered for procurement by the USAF it is recommended that the following items be accomplished to improve the general capabilities of the aircraft:

1.) A study be accomplished to determine the growth potential of the aircraft.
2.) Excess thrust at all speeds be increased.
3.) Stabilizer yoke flutter be eliminated.
4.) Transonic longitudinal trim change be eliminated.
5.) Adequate stall warning be provided for the powered approach and landing configurations.
6.) Excessive trim changes due to flap retraction and extension be reduced.
7.) Lateral control sensitivity be reduced in the power approach configuration.
8.) A program be conducted to determine lateral control characteristics above Mach 1.1 so that present restrictions can be removed, and lateral control effectiveness be increased at high mach numbers.

If the Grumman design 98J is to be procured for USAF use, a board should be appointed to evaluate the

At right, USAF Colonel Joe Davis, Chief of Fighter Flight Test at Edwards AFB taking his indoctrination ride in the number one Super Tiger. (via Meyer)

importance of existing deficiencies and to determine the growth potential of the aircraft. (end of report)

We were very appreciative of their high praise of the fundamental flight characteristics of the Super Tiger. The reason the stabilizer yoke flutter was highlighted twice was that Gen. Holtoner accidentally flew faster than the low altitude speed restriction by about 50 knots and entered the flutter range. He was a sharp enough test pilot to turn the instrumentation on and record the frequencies. This was a great help for our redesign. He and we were also very fortunate that although the flutter had a large amplitude it was not catastrophic!

The Air Force had measured takeoff and landing distances which we had not had the time to include in our test schedule. Their figures showed that the Super Tiger could be flown in and out of a 6,000 foot runway without a drag chute, which was standard equipment on all Century Series fighters.

General Holtoner was so impressed with the Super Tiger that he persuaded General Al Boyd, who was the Commander of ARDC, to come to Edwards to evaluate the airplane. General Boyd was even more pointed in his remarks. He stated that the Super Tiger could handle the MiG-19s and MiG-21s that would be operational behind the Iron Curtain in the coming years. This was high praise coming from the USAF. General Boyd and his people were very helpful to my upcoming job change.

NEW F11F-1F PROJECT PILOTS:

At the completion of the Navy and USAF evaluations in November of 1956, and because of the upcoming German fighter competition, the author left the test flying program to become a full-time Super Tiger Project Salesman.

Bob Smyth became the Grumman project pilot from December 1956 until March 1957. He flew 13 performance and flutter flights to continue fleshing out a complete flight envelope to 550 knots airspeed at all altitudes.

Before he completed this program, Bob had other commitments on Grumman Demonstrations, so he turned over his program to John Norris who had just completed the Tiger carrier suitability demonstration and the Cougar Trainers structural demonstration at NATC Patuxent.

John's commitment to go to Edwards AFB for three months turned out to be three years of very interesting flying. After he had been checked out, John continued the flight envelope expansion to 550 knots and 1.85 Mach. The Super Tiger now had a sufficient flight envelope for interested test pilots to fully understand the aircraft's potential.

Below, the two Super Tigers, early in the test program. The number one bird with the dummy Sidewinders and the large folding ventral fins was used during the Air Force test flights. The fins were added for additional directional stability on the first 1.85 Mach runs, which proved they would not be needed. (via Craig Kaston)

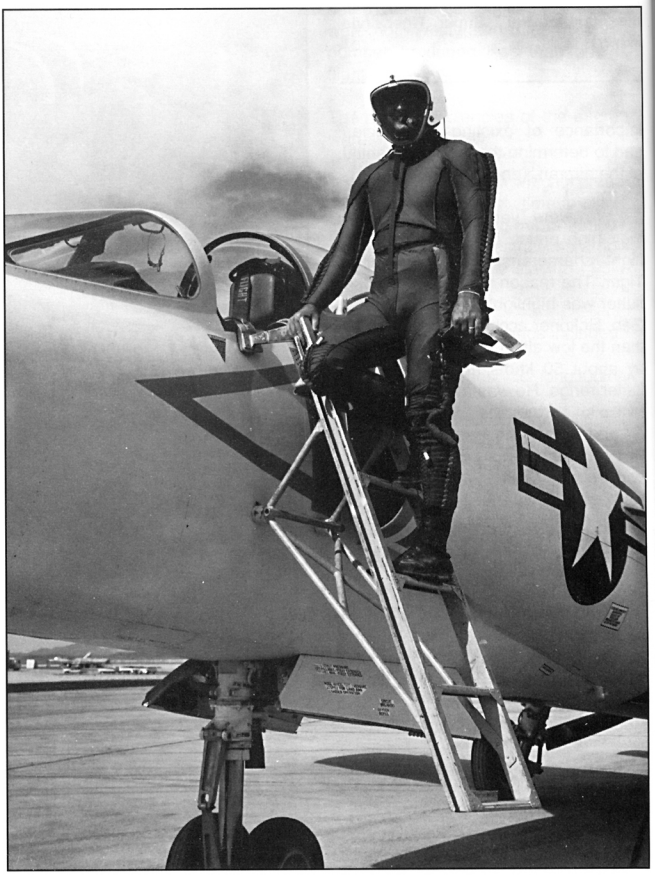
Meanwhile, the F-104 was pushing its way out to Mach 2.0. Grumman decided to push the Super Tiger to its Mach limit by climbing the airplane above 40,000 feet at 550 knots until it reached Mach 2.0. At the same time, Grumman decided to see if the Super Tiger could crack the world altitude record of 72,000 feet held by Russia. To be official, the previous record had to be exceeded by 5%, or about 3,600 feet. From the zoom climb that I had performed in November 1956, it appeared that the Super Tiger would have a very good chance to break the world record if it could attain Mach 2.0 above 40,000 feet.

Using BuNo. 138647, John started the first mission from Mach 2.0 at 41,000 feet by pulling up to his desired climb angle and letting the airplane go ballistic until it went over the top of the arc at something like 90 knots airspeed. This was well below its 1G stall speed. Gravity then started accelerating the aircraft back to normal flight speeds. The afterburner blew out at 62,000 going up and the altitude reached was slightly over 72,000 feet. The only new characteristic noted was a tendency to do a Dutch Roll (lateral-directional oscillation) because of the deterioration of the directional stability as the Mach number increased above 1.85 Mach. He made two more flights starting at Mach 2.0, but increasing the zoom start pull-up schedule. On his last flight he achieved an altitude of over 75,000 feet. We now knew that we could bring the altitude record home to the U.S.

THE EARTH REALLY IS ROUND:

John Norris describes his final zoom climb that unofficially broke both the world official speed and altitude records on the same flight:

"On 2 May 1957, we got the day we had been waiting for. The upper air temperature was about 10° below standard, and with Capt. Bob White as chase, we hit paydirt. With those atmospheric conditions, I easily achieved Mach 2.04 when I got to the pull-up point. The Dutch Roll tendency was more pronounced at the higher Mach number and the 2.5 G ten second pull-up schedule, and then an interesting complication developed: at about 76,000 feet, I lost control of the engine as it began to exceed the maximum allowable exhaust gas temperature limit. At that altitude the engine fuel control had cut back fuel flow to the lowest level it could regulate. Even though I reduced the throttle angle from military to idle, the minimum fuel flow was higher than the engine could accept and remain below temperature limits; it was stuck on full RPM with EGT rising. The only thing I could think of to get control of the engine to prevent an overheat, with all the problems that could develop, was to shut it down. As I stopcocked the throttle, I remembered the demonstration drill at Wright-Patterson during my pressure suit check-out. A mouse was exposed to explosive decompression at 65,000 feet and the remains were hardly enough to collect.



Above, John Norris poses on the ladder of the Super Tiger in which he set unofficial world speed and altitude records on 2 May 1957. (John Norris)

The David Clark T-1 Suit came through beautifully, instantly tightened smartly, and I topped out at roughly 70 KIAS and just above 82,000 feet indicated altitude. Since the engine was not running, and I wasn't in any danger of crashing into anything, I decided for the first time that I could take the time to look around. In my flight report I noted that the sky was dark blue, I could see the Bay of California and the earth really is round. I thought that was about as exciting as flight testing could get. I was wrong!

The J79 started quickly and easily when we got back to air-start altitude, but I made a Simulated Flame Out Landing approach anyway just to be on the safe side. The engine was fine but, since SFO approaches are fun, I made them at the end of zoom climb missions on subsequent flights. The zoom climb missions were just plain, grinning-all-over-myself, fun to fly.

Some pilots were very uncomfortable in the T-1 suit, but with its performance I became very attached to mine and relatively cozy in it.

FROM RUSSIA WITH LOVE:

An interesting part of '58 was the program to return the World Altitude Record to the United States from Russia. The year before, we had developed the data to show that we had the performance to exceed the existing record by a significant margin. Early in the year, we got Grumman's clearance to continue to evaluate the profile and have a go at the record. I made 8 climb missions with BuNo 138646 to refine the G schedule, and by April we had a good handle on energy transfer. I'd tried varying the entry from achieving peak G at the 30 second point to loading it up rapidly in 3 seconds. In the latter, the enormous trim drag of the deflected stabilizer at the high Mach number was a lot like a speed brake and cut several thousand feet off the apogee. That was not a candidate.

We did not know our true altitude because we didn't have the use of the Edwards Space Positioning Phototheodolite System. We simply used photopanel and cockpit data, which agreed well, on the basis that we could use those numbers to compare one flight to another and, that way, evaluate the effectiveness of changes to the pull-up schedule.

Above, Super Tiger undergoing an engine change at Edwards after being FODed in flight by a starter rivet. (via S. Nicolau)

In March, the basic engine quit just after afterburner blowout and I cut the profile off just above 70,000 feet. The air start was successful and the engine gauges looked normal, but engine acceleration was crummy and it just didn't feel right. I asked my chase, Maj. H. M. "Mac" Lane, a real gentleman and one of the fine aviators we worked with at Edwards, if he thought-lake bed or runway. Mac said, "Lake bed's still wet, suggest the runway." That looked like the best option to me, too, and I made the SFO landing on runway 04. As I rolled out, Mac sailed by on my right side in his 104 and said, "Nice job, Johnny."

At left, group shot of the Grumman flight test team at Edwards during the time when CDR Watkins regained the World Altitude Record from Russia. He is in the cockpit with John Norris and Joe Myer checking him out. Standing left to right: BuAer fighter desk, LCDR Bill Hoover, W. Ottinger, L. Schatz, P. Butler, K. Edwards, F. Rowley, R. Coles, L. Frost, B. Leonhardt, T. Harmon, R. Mullaney, Dr. D. Johnson, S. Ferdman, and C. Wheeley. (Corky Meyer)

Above, the first Super Tiger as used for the record flights with bondoed area just aft of the red nose cone. (USN via Kaston)

I thought I had made a pretty good pattern, but coming from him that comment felt even better.

We towed the airplane back to our ramp and found that a rivet from the starter housing had come lose, gone through the engine and chewed up the blades to beat hell. Why and how it ran at all I still don't understand.

Shortly after that, with a new engine, I was turning into the Edwards Supersonic Test Corridor for the acceleration back to Edwards when the pressure helmet face plate heater quit. That was a problem because my exhaled breath fogged up the face plate glass big time and I couldn't see past my nose. I didn't want to abort the mission at that point and found a workable solution: when I breathed "in", the incoming dry, 100% oxygen, instantly cleared the fog. That encouraged me to continue with the acceleration. Climb and recovery was made breathing "in", holding my breath for as long as comfortable, then breathing "out" and "in" quickly to clear the visor during the eight or nine minutes the acceleration/climb/recovery profile required. It just worked fine and, although a mild nuisance, I think was perfectly safe. If I had lost pressurization the T-1 would have applied high pressure, dry oxygen to the helmet in large volumes; that's the way it worked. So breathing "in" (translation: clear vision) would be quick and easy -- with the T-1, breathing "out" was the difficult cycle.

In reality, I suspect, that wasn't the first or only time I passed through 70,000 feet holding my breath.

At left, CDR Watkins received his first congratulating handshake from Project Pilot John Norris. The two-man team worked together on "Operation Apollo", resulting in a new Worlds Altitude Record. (USN via S. Nicolau)

With the climb schedule now well understood, we were ready to have a go at the Russians. The Navy took the not-unreasonable position that they didn't want a civilian to hold the record in one of their airplanes and, since they had the gold, they made the rules.

WORLD ALTITUDE RECORD SET:

On 12 April 1958, LCDR George Watkins returned the World Altitude Record to the United States with a flight in '646 measured by Edwards Space Positioning and verified by FAI (Federationale Aeronautique Internationale) to 75,550 feet. If there had been a trophy for the record, it would have been on an Aeroflot Tupolev headed for Edwards. We all felt damned good about the record!

NOTHING IS EVER AS SIMPLE AS IT SEEMS:

On 24 August 1959, we rolled 138647 out of the barn after an engine change and launched for a simple check flight just before the start of a joint evaluation by the US and Japanese Air Forces. I didn't request a chase because I was going to confirm that engine No. 113, which was the best powerplant we had, was operating normally for the coming flight series. Even though the flight was planned to 50,000 feet where a pressure suit is required, I elected (stupidly) not to wear mine.

I took off on runway 04 in mid-afternoon to do an afterburner climb for data for our own comparison with the test points we understood would be run by the evaluation team. Unless required by the mission, we climbed out at military power to conserve fuel. Consequently, we didn't have a great deal of recent afterburner climb data.

In perfectly normal operation, I chatted with the Telemetering station and continued the climb to 50,000 feet, so we'd have data higher than the evaluators were likely to record. Oddly, the rate of climb wasn't all that great the last couple of thousand feet.

Below, 138646 during a minimum distance landing maneuver. Even with this high angle of attack, visibility over the nose was quite good. (Grumman)

While feeling very comfortable about the afternoon and the way things were going, I came confidently out of afterburner and good old faithful 113 quit cold!

At that altitude an air start wasn't possible or even a high priority. As cockpit pressure was rapidly going to assume ambient altitude, the first order of business was to get down below a level where I would be safe from the lack of positive partial pressure of oxygen, which was 43,000 feet with our oxygen system and mask configuration. I went to 100% oxygen and pressure breathing quickly. I started a left descending turn back towards Edwards. In that turn, it became quickly clear that from my position and the heavy (almost take-off) weight, I didn't have enough energy to complete the turn and get back to Edwards.

Down below 43,000 I set up a 250 KIAS glide, which is pretty close to the clean configuration minimum drag speed (minimum sink) and, even though I was confident that the engine would restart, started looking over my dry lake bed options. That

airspeed was also well within the air-start envelope, gave good windmilling RPM for hydraulics, and was the speed that I'd been using in the past for simulated flame-out landings.

The closest choices were the Three Sisters and Harper Dry Lake Beds as I was turning between them. My concern was that we were in the thunderstorm season and had several real gully washers in the past few days. Sure enough, both were clearly dark and wet, and that was a problem. Cuddeback was a better option because it's a little higher and is farther north, so it's less in the thunderstorm track. As I settled into the air start envelope, below 35,000 feet, I headed in that direction.

I reported to telemetering the condition of the lakes and my intent to head toward Cuddeback, and started through the air start sequence with great confidence. I called out "Air Start Ignition: ON. Throttle: AROUND THE HORN TO IDLE. Fuel Flow is . . . Hmmmm! Fuel flow is not coming up, it's zero and I do not have a start." Cuddeback was now in sight, in range, and, most importantly, looked relatively dry. With that reported to Telemetering, I ran through the air start sequence for the sixth time, with identical results: no fuel flow, no start.

With plenty of windmilling RPM at 250 knots to maintain 3,000 psi hydraulic pressure for both the flight and utility hydraulic systems, I concentrated on setting up the standard 360° approach for an overhead flame out landing pattern at about 14,000 to 16,000 feet, which would compensate for my heavy weight fuel condition. Coming into my high key spot for my final 360° approach, with plenty of energy to hit my landing spot, I deployed my auxiliary ram air hydraulic turbine for extra control power, my landing gear and my flaps. As I started the critical landing flair with my dead engine, I murmured the prayer of all test pilots in a tight spot, "Please God, don't let me screw up!"

Touchdown was made just south of the road, and I used all the aerodynamic braking I could maintain. I could feel the increased drag of the wheels settling just a little into the damp lake bed surface. That pulled the nose down somewhat earlier than on a hard surface runway. With the rolling drag, I let the airplane run out unbraked to avoid any chance of a brake lock and resultant overheat. I turned slightly toward the east side of the lake bed because that looked to be the dryer side. As the airplane coasted to a stop, I said to myself, "Sumbitch, that worked out pretty good!" Then I unstrapped, got out, scrambled across the fuselage, slid down onto the horizontal stabilizer, and from there to the lake bed.

I walked around the airplane looking for anything that would explain the failure to start and couldn't find a thing. Everything was where it should be. The fuselage and the tailpipe interior were as dry as a bone. There was nothing unusual at all.

Within a very few minutes, a B-47 came by at about 3,000 feet and flew north to south down the center of the lake bed. About two minutes later, a T-33 from Edwards Test Pilot School came by in the same direction, except that it was at about 50 feet. I waved to the crew, they rocked the T-Bird's wings and climbed out towards Edwards. Great! That meant people knew where I was and that the airplane and I were okay. Pretty soon someone would come out to help. A few minutes later, a car with some Cuddeback Gunnery Range personnel drove up and took me to their phone where I called my ground crew to pick me up.

Below, Super Tiger, BuNo 138647, being serviced at Edwards. At this time ,aircraft was white overall with red trim and polished metal tail pipe. Note the three red intake and wing strips and the designation 98J-11 on the aft fuselage below NAVY. (via Kaston)

The next day, a USAF crew came to Cuddeback with a monstrous aircraft retrieval trailer called the dust bin, picked up the airplane and, with the help of the California Highway Patrol , delivered it safely to Edwards.

A ground run showed the same condition with no fuel flow indication during a start cycle. Tear-down inspection of the fuel control disclosed that the fuel pressure shutdown dump valve, which dumps excess fuel from the combustor lines when the throttle is closed, somehow stuck in the closed position when I came out of afterburner, and in doing so stopped fuel from getting into the combusters, which prevented engine start. A very small, strange, isolated, but almost disastrous occurrence."

FLUTTER, THE PILOT'S WORST ENEMY:

Flutter is the self-excitation of a wing, tail or control surface of an airplane from unpredictable, unstable aerodynamic loads or Mach number effects. Because of the very thin (3%) horizontal tail surface, pre-flight calculations and ground shake tests had forecast that the Super Tiger's horizontal tail surface would flutter at about 600 knots. That is why we limited the speed of the airplane to 550 knots. My flight tests happily demonstrated no flutter tendencies up to 550 knots. When General Holtoner accidentally exceeded that limit during his flight, he felt the airplane start shaking almost at the predicted speed. Not knowing where the shaking was coming from, he fortuitously took records which were very helpful in our later designs.

Many times, flutter at high speeds or Mach numbers instantly destructs that portion which flutters and, if violent enough, has been known to destroy the entire aircraft. The flutter that he experienced was fortunately not destructive, but if he hadn't stopped increasing his speed immediately it would have been. Therefore, flutter flight testing is done very slowly and carefully. The pilot never knows how fast flutter can go destructive after a surface starts oscillating. The Super Tiger, with its ultra-thin horizontal tail surface and much higher Mach number capability, was to enter into a flight regime way beyond that which the Tiger had been tested.

In order to open the aircraft speed/Mach envelope to 725 knots, which is the intake duct structural limit, John Norris started a three year flutter program, testing combinations of many different stabilizers, stabilizer yokes, and stabilizer attachment fittings. It took him and his structural flight test team 106 flights to find the right combinations of aluminum and steel structures satisfactory for the final flight envelope. The final structures were mostly steel, but they were much heavier than the designers wanted.

Just before the joint USAF/ Japanese evaluations in September 1959, the team had been able to open the flight airspeed/Mach envelope from 550 knots to 725 knots with limit Mach numbers of 1.46 at 15,000 feet, 1.75 Mach at 27,500 feet, and 2.0 Mach above 35,000 feet, which was the original aircraft design specification.

Top, #2 Super Tiger sets down on Edwards runway. (Grumman) Below, the 2nd Super Tiger on Cuddeback dry lake after John Norris (at left) flamed out. Saul Ferdman is at right. (John Norris)

HORIZONTAL TAIL FLUTTER TESTING BY JOHN NORRIS

At left, Super Tiger number one as it appeared in early 1958 at the start of Norris's flutter test program. The Grumman logo and two thin, white stripes have been added to the da-glo red nose cone. (Grumman via S. Nicolau)

At right, head-on view emphasizing the voracious intake ducts and narrow track landing gear of the Super Tiger. (Grumman via S. Nicolau)

JOHN NORRIS REMEMBERS:

"Our flutter evaluation of each new combination was complicated by the need for a different excitation system for each one, none of which could, at the time of assembly, be predicted or planned and set up with each package change. We tried single mass shakers with varying masses, multiple mass shakers in varying shaker planes and varying masses, and finally rocket excitation devices. We tried black magic mixed with pragmatic flight testing: what worked, worked, and we went with that. Some didn't, and that's the lead for this bit of nostalgia.

In early 1958, we had a crummy combination on 138646 and we knew it quickly. We were moving ahead in 5 knot IAS increments, and at a relatively low EAS the configuration went unstable. I had just finished a test point around 1.55 Mach at 40,000 feet, and was holding that test speed as an IAS number while I waited as George Gayes, head of structural flight testing at the time, and his team analyzed the data. Instead of clearance to the next point, George called to me over the test frequency, "646, if you're running the shaker stop it, if not, slow down" The intent of that message was instantly clear even though delivered in a calm, unhurried voice. The shaker wasn't, and I did.

At the debrief, George showed me the Telemetered data. While the team was crunching numbers, the stabilizer had started a yaw oscillation at a very low amplitude without shaker excitation. The marriage of that set of stabilizer/yoke/fittings quietly ended.

On 19 May 1959, virtually the same event occurred. We were evaluating a 3% stabilizer with aluminum yoke and "revised fittings". I was again holding speed between points and Saul Ferdman, now head of the structural evaluation test program, could have been focused on anything but the Telemetry Brown Recorder traces as his team evaluated the data from the last test point. Fortunately for me, he had not relaxed his focus one bit. The call I got from him was cool and businesslike, but it had a clear sense of urgency about it: "647, slow down." No raised pitch to the voice, no transmitted nervousness, just the message. It didn't need to be repeated.

In textbook engineering understatement, Saul reported in his report, "self-excited flutter occurred at 490 KEAS and 27,500." So ended the 3% aluminum modified fittings caper.

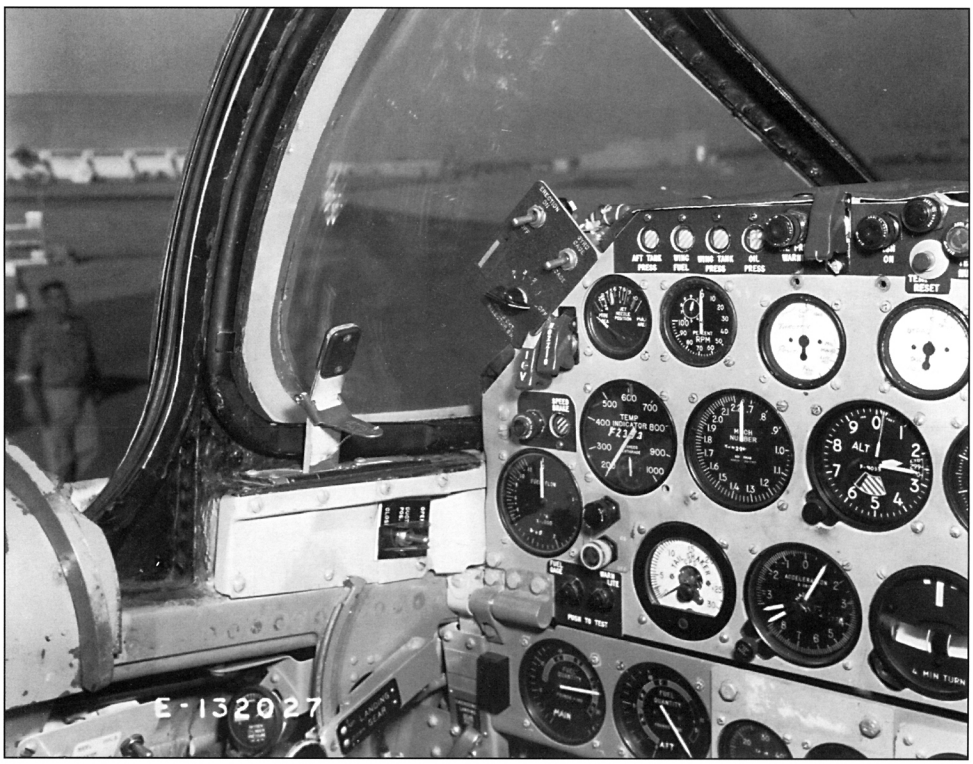
How do you thank guys whose skill and dedication directly contribute to your continued journey through this sorry veil of tears? Do you bang 'em on the fanny and say something like,

Below, BuNo 138647 in front of an Edwards AFB hangar. Note the 98J-11 stenciled on the nose. (via Kaston)

F11F-1F SUPER TIGER RIGHT-HAND CONSOLE

"Nice work, hamburger, how come you woke up from your nap at the right time?" Somehow you don't do it right, and you feel inadequate because you don't. But you know how it was and how it could have been, and they know you know. Maybe that's what's important. I guess that's the way it is in a business in which what everyone does, and how well they do it, makes the difference between breaking things and hurting people and everybody going safely home to their families at the end of the day. It takes a team, and they ain't all in the air."

F11F-1F INSTRUMENT TEST PANEL



EXTERNAL STORES FLIGHT ENVELOPE TEST PROGRAM

For a fighter to be a working multi-mission airplane, it needs to have a separate program to determine the structural, flutter, and handling limitations of all possible store configurations in order to be certain that the characteristics of the aircraft with a wide variety of stores will have a satisfactory operational envelope.

Although the Super Tiger did not have a firm purchaser, Grumman management knew that certain basic external stores would be in the requirements of a buyer's air force. Therefore, the following seven store configurations were demonstrated in flight to their limits prior to the second USAF/Japanese evaluation:

1.) Two AIM-9 Sidewinder air-to-air missiles on a centerline rack, Mach 2.0.

2.) Two AIM-9 Sidewinder air-to-air missiles mounted on the upper fuselage (mounted behind the cockpit in tandem), Mach 2.0.

3.) One centerline rack-mounted Mk. 83 1,000 pound bomb, two Aero 1C 150 gallon drop tanks, and two wing mounted AIM-9 Sidewinder air-to-air missiles. 450 knots indicated airspeed from 15,000 to 40,000 feet.

4.) Two Aero 1C 150 gallon drop tanks, two AIM-9 Sidewinder air-to-air missiles, all mounted on wing racks, Mach 1.5.

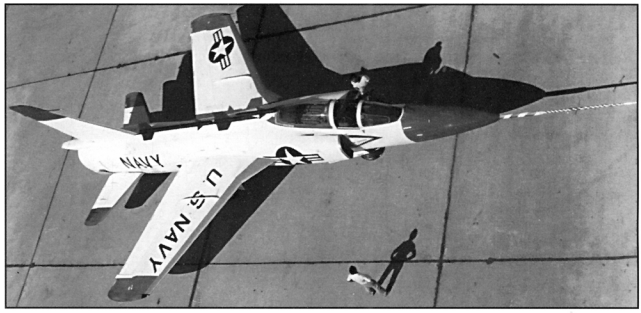
5.) Two Aero 1C 150 gallon drop tanks, two Hughes Falcon air-to-air missiles, all mounted on wing racks, Mach 1.4.

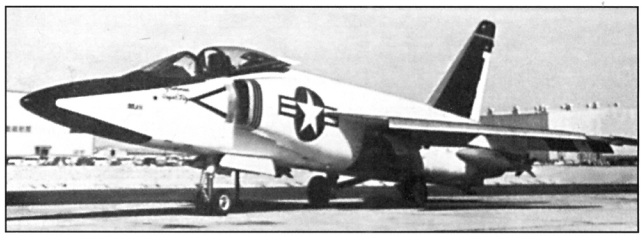
6.) Two wing-mounted Mk. 83 1,000 pound bombs, Mach 1.4.

7.) Mounted, but not flown, two Bullpups and two Sidewinder air-to-air missiles, all mounted on wing racks.

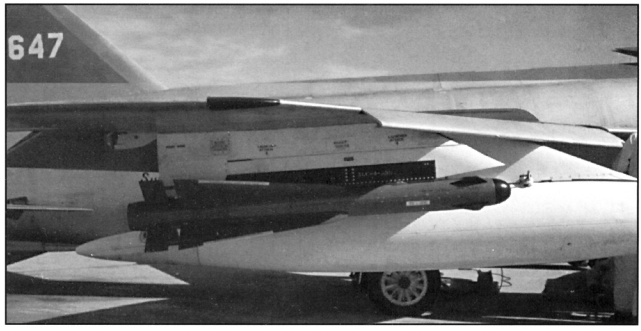
Not a bad multi-mission Mach 2.0 fighter airplane.

Above, an AIM-9 Sidewinder being loaded on the wing pylon of 138647. (Grumman via S. Nicolaou) Below, Mach 2.0 capable dorsal-mounted Sidewinders on 138646. (Grumman via Corky Meyer)





Above, Mach 1.4 capable wing-mounted Mk. 83 1,000 pound bombs fitted on 138647. (Grumman) Below, Mach 1.4 capable wing-mounted Aero 1C 150 gallon drop tanks and two Hughes Falcon missiles mounted on 138647. (via Craig Kaston)



Above, 138647 early in the test program with two AIM-9 Sidewinder missiles mounted on the wings. (Grumman)

Above, 138647 in flight with centerline rack-mounted Mk. 83 1,000 pound bomb and wing-mounted Aero 1C 150 gallon drop tanks. (via John Norris) Below, Mach 1.5 capable wing-mounted Aero 1C 150 gallon drop tanks and two AIM-9 Sidewinder air-to-air missiles mounted on 138647. (via Craig Kaston)

Above, twin centerline-mounted AIM-9 Sidewinder air-to-air missiles and two Aero 1C 150 gallon drop tanks mounted on 138647. (Grumman)

Above, 138647 taxis out fitted with one centerline-mounted 1,000 pound bomb, two Aero 1C 150 gallon drop tanks and two AIM-9 wing-mounted Sidewinder missiles. With this load, the aircraft was limited to 450 knots. (Grumman via Kaston) Below, 138646, shortly before its demise, fitted with wing-mounted Bullpup and Sidewinder missiles. (via S. Nicolaou)

UNOFFICIAL, BUT DEDICATED, SUPER TIGER SALES TEAM IS FORMED

Phenomenal enthusiasm for the Super Tiger in the lower Grumman echelons was generated by the NPE and USAF evaluation reports. Those areas in Grumman, like the phoenix, had risen from the ashes of the under-performing Tiger to the mercurial performance of the Super Tiger. The Super Tiger was really only a Tiger with a simple engine change, and the Tiger was now a fully-tested, in-production, and in-service airplane. Although top management was not pushing the program, a band of "Young Turks" from flight test and engineering banded together to seek customers for the latest hot-performing Grumman Cat.

Corky Meyer was the Senior Engineering Test Pilot, project test pilot of fighters since the Hellcat and project pilot on the Tiger and Super Tiger. After the Navy and USAF evaluations, he temporarily left test flying to try to sell the Super Tiger worldwide. Corky specialized in Germany, Switzerland, Canada and Washington.

Herb Crawford was the Chief of Flight Test when he was asked by Corky to take over the Japanese program in August 1957.

Bob Miller was Chief of Aerodynamics who specialized in fighters, and was very good at packaging new sales proposals.

Bob Mullaney was Chief of Propulsion who had been a Navy attack pilot in WWII and understood the military mind-set.

Gordon Ochenrider was a former Navy fighter pilot and understood the Washington scene. He later took over the European office in Geneva, Switzerland.

Bob Munch was Administrator of the Super Tiger operation at Edwards. He had worked in Flight Test since WWII, and had a great rapport with military test pilots. He went with Herb Crawford to Japan.

Ed Zolkowski (from flight test) specialized in international sales of Grumman amphibians. He also went to Japan with Herb Crawford to.

What we lacked in sales training or knowledge, we had in enthusiasm and freedom-of-action. We all firmly believed that the Super Tiger was needed in an air force somewhere.

Nobody on the team was a corporate officer. Until after 1 January 1958, we were not allowed to have a corporate officer in attendence of any customer meeting at the home office or in the field. We met competition corporate presidents world-wide.

USAF AND THE SUPER TIGER:

Our first customer appeared to be the USAF. Although the Super Tiger did not have quite the performance of the Lockheed F-104, it did have a combat radius of over twice that of the Starfighter and was reported by the USAF to be a much simpler airplane for pilot acceptance. It should be noted that four F-104s had been lost to accidents by this time, and there were still many fundamental problems to solve. An illustration of the difference between the two airplanes was the flame-out landing characteristics. The Super Tiger had a 360° overhead pattern that started at 12,000 feet and 180 knots with the landing gear and flaps down. Its flare-out and landing were normal. Whereas the F-104 had a 20,000 foot start altitude with a 220 knot speed with flaps only. Flare-out altitude was 5,000 feet, and the landing gear extension had to be delayed to the last few seconds before touchdown or there wouldn't be enough elevator power to make the flare-out. After several crashes from this maneuver, F-104 pilots decided that ejection was the only sane solution in this situation. We saw two disastrous attempts at

Below, Air Force pilot dismounts from Super Tiger as John Norris waits to greet him. (via Kaston)

flame-out landings at Edwards.

In early 1957, I received permission to fly the F-104. As I got into the cockpit for my first flight, I was told to complete my two flights immediately because Lockheed had persuaded USAF officials to cancel my clearance. My informant said that they could hold its effective time back until noon. Those two flights convinced me that any pilot who flew it would surely forgive its many ills in light of its suprising performance. I now knew our competitor intimately.

What follows is the first page of my 12 page flight report on the F-104:

CONFIDENTIAL

FLIGHT REPORT F-104A
October 9,1957

CORWIN H. MEYER

SUMARY:The F-104A had good, but very short range. It has, however, several serious limitations that will make it difficult to employ as an Air Defense Command weapons system and almost impossible to employ as a Tactical Air Command weapon system. The limitations are basic enough to restrict growth potential.

This aircraft design has sacrificed acceptable flying quailities and safety too much in favor of performance.

Good items noted in the F-104A"

1. Performance
2. Lateral and longitudinal control harmony.
3. Cockpit size, layout and visibility.
4. Speed brakes.

Unacceptable items:

1. Very restricted longitudinal control power for high altitude manuevering in order to prevent t-tail pitch up.
2. Very high take off speed-185 knots, very high landing speed-170 knots.
3. Very short radius of action-55 nautical miles.
4. Very low rolling performance restriction because of intertial coupling.
5. Small flight restriction envelope after 3 years of flight testing.
6. Poor duct-afterburner operation at high speeds-strong duct rumble.
7. Poor Directional stability, damping, and breakout forces at all speeds.
8. Poor pilot psyschology-engine out landings not recommended by USAF.
9. Poor gun latform because of 1, 4, 6, and 7.
10. Complicated pilot's harness and downward ejection seat.

INTRODUCTION: Permission was granted the writer to make two flights in F-104 A at Edwards Air force Base. Two 35 minute flights were made October 7, 1957 in F-104A-734. This airplane was being used in Phase IV (Service Test) during the time of the flights. F-104A Number 56-1734a is a Block One Aircraft.

CAPT Kincheloe, the project pilot for the USAF evaluation, set Grumman up for a presentation at headquarters ARDC, which we made in early December 1956. COL Gordon Duncan was assigned by GEN Al Boyd as our project coordinator, and we couldn't have had a more enthusiastic "assistant". He set up five presentations in various important sectors of USAF headquarters. All were received with enough ardor that the head of each one of these departments went to Edwards to fly our aircraft and see this wonder-bird for himself. They returned with glowing reports. The area that was of the most immediate assistance to our new sales team was the USAF Military Assistance Group. The MAG helped friendly countries world-wide procure and utilize American military airplanes. They informed us that both the Federal Republic of Germany and the Japanese Self Defense Force were planning to evaluate all available supersonic fighters in order to modernize their air forces. They would send teams to the United States shortly. The MAG had not yet heard of the Super Tiger, but they obligingly put Grumman on their visit list. They also told us that the Japanese were not quite ready to send teams to the U.S., but the German team would be arriving on 19 February 1957.

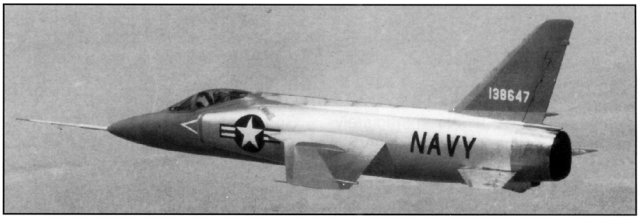
It must be noted that Grumman's sales team was comprised of only four full-time people. None had ever been on a sales program before. We needed to cover ARDC Baltimore, USAF and USN headquarters in Washington, Edwards Air Force Base and Grumman to prepare presentations for these up-coming sales clients. Our efforts would eventually blossom into France, Great Britain and Canada. We assumed that the first buyer would set the stage for the rest of the other countries, so we concentrated on Germany.

Although the evaluations by the five Colonels gave some temporary impetus to the Super Tiger in the Pentagon, it slowly became clear to us that the USAF had the same problem as the Navy. They would not be a prime customer.

The USAF had already spent a lot of money on five programs: the F-100 Super Sabre, F-101 Voodoo, F-102 Delta Dagger, F-104 Starfighter, and the F-105 Thunderchief. The F-104 Starfighter was the only one that was in our performance category. Because it had no all-weather abilities, had 49 accidents and lost 18 pilots in the first 100,000 flight hours and had such limited combat range, the USAF limited their procurement to 296 aircraft. The USAF tacitly decided that the F-104 would be their sales entry to the upcoming German evaluation team.

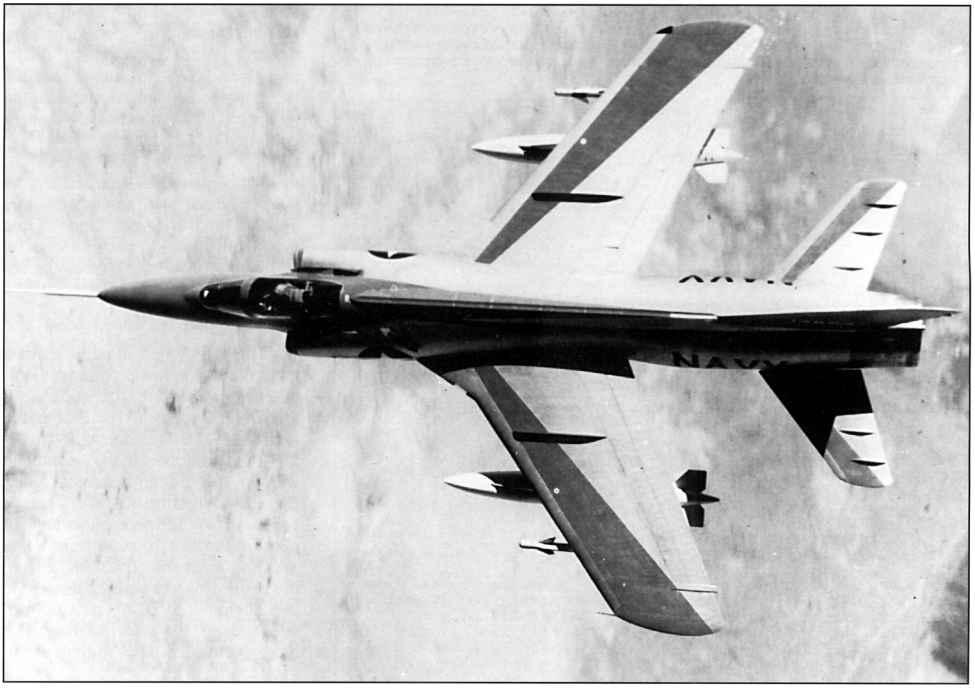
THE LAST NAVY PROPOSAL:

We still thought that we should give the Navy another try. I visited CAPT Joe Smith, head of the Fighter Branch of Bureau of Aeronautics, who was a long-time associate. He set up a presentation for Grumman, but qualified it with the statement that it would do us no good. The Navy had made up its mind. We would receive a final, positive and strongly worded "NO" at the end of the presentation. Our enthusiasm knew no bounds so we accepted those terms. We were amazed at the high interest shown by senior Naval officers attending the presentation. At the end, CAPT Smith excused us and told us to wait outside for the "NO". Two hours later he came out and said that the "NO" would have to be delayed indefinitely. This improved our outlook, but several days later he called me and said that the recommendation to re-evaluate the Super Tiger for procurement unexpectedly went up to the top of the Navy with positive recommendations, but was killed very dead. He was as amazed as I was that it went that far, but it was in fact Navy-dead once-and-for-all. As a side benefit however, Admiral Bill Schoech, head of the Bureau, called me in and said that I should directly contact his office should I need help in the forthcoming German evaluation. He stated that he wanted the Super Tiger to win the competition to let the world know that the U.S. Navy could design and produce a respected supersonic fighter. He would personally be a great help in many inter-service problems that arose later.



Above, the silver and red second Super Tiger in August 1957 without the folding ventral fins that were originally installed on the number one Super Tiger. (via Craig Kaston)

Below, the number two Super Tiger shows the colorful red wing and fuselage stripes and the grooved fuselage hump designed to carry two Sidewinder missiles in tandem. (via Craig kaston)



GERMAN TEAM ARRIVES:

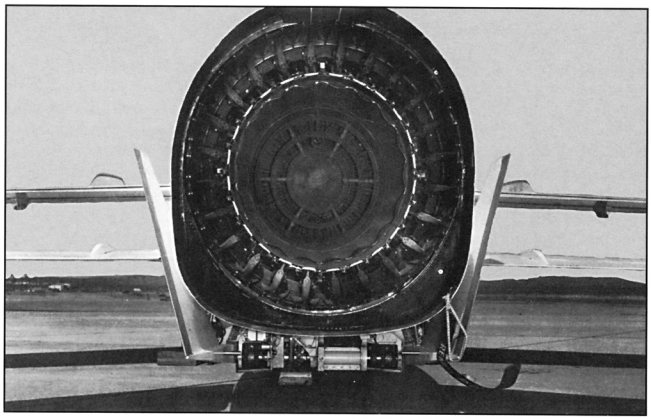
The first German team of 15 experts from all the important areas of their Air Force was lead by the Famous WWII night fighter Commander, General Kammhuber. They were to evaluate 14 fighters world-wide, including the Swedish SAAB Viggen, French Dassault Mirage, British English Electric Lightning, and the Italian Fiat G-91. LCOL Albert Werner was their test pilot. He had been a test pilot throughout WWII and had some very intersting stories how they would fly to the nearest front for live operational testing with a prototype ASAP in order to save time! He flew all of the American aircraft on the USAF list including six flights in our Super Tiger.

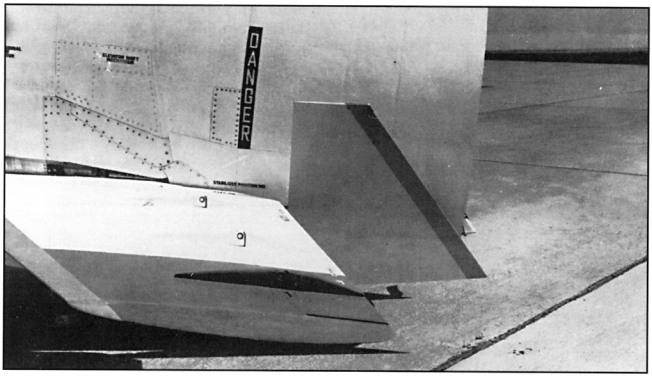
Above, the first German flight test team in February 1957 at Edwards AFB. From left to right: Capt. Heinrich Knerier, adjutant to Col. Werner, the author, "Corky" Meyer, Maj. Lane, Director of Fighter Test, Col. Albert Werner, German test pilot, and Grumman's "impressed German" Josef Hubert, formerly of Messerschmitt. (Corky Meyer)

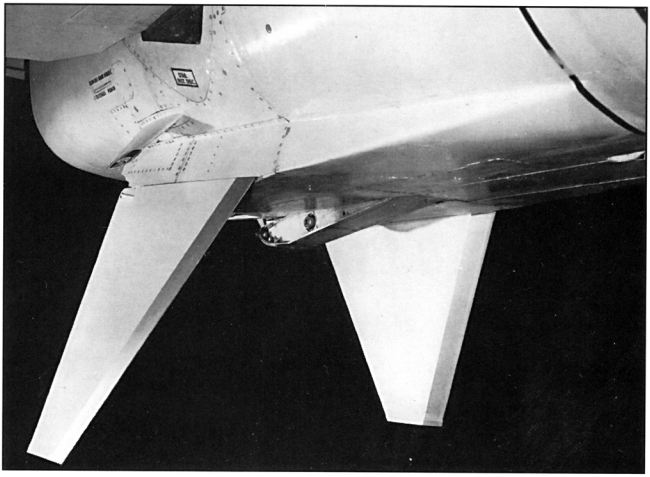
GERMAN STRUCTURAL TESTING FOR THE SUPER TIGER:

When GEN Kammhuber landed from his second flight, he was furious. He said that we had lied to him about our performance. He further sputtered that the Super Tiger would only go Mach 1.1 after many minutes in A/B power. We were flabbergasted until we found out from the chase pilot that he had never retracted the flaps and slats!! We checked the entire airplane structure and surprisingly enough found no damage. Records showed that he had attained 700 knots, which was 405 knots over the structural limits for extension of the flaps and slats. Talk about the Grumman Ironworks!!

Below, the number one airplane with the retractable ventral fins in the retracted position. They were installed to give the pilot surplus directional stability for the first runs over Mach 1.85. On the second flight of the German test pilot , he forgot to put them up and wiped them off the fuselage during landing. Grumman had verified that they were not needed and they were not replaced. (Corwin Meyer)







His final and enthusiastic report stated that our airplane was the very best of all the airplanes he had evaluated because of its performance, but especially for its docile handling qualities in the take-off and landing pattern. He was realistic in thinking that easy handling qualities would be needed for their new generation of German supersonic fighter pilots.

It was interesting that when the many F-104 accidents were discussed openly, Lockheed officials had a very smooth answer. They said that any airplane that was so advanced as the F-104 would have accidents, but they would be a thing of the past when the German Air Force finally received them. This propaganda was swallowed by many of the foreign evaluators, including GEN Steinhoff, Chief of the Luftwaffe.

The next German visits to both the Grumman factory and Edwards were by government procurement personnel, followed by a German commercial manufacturing team. Five groups of German experts visited us and all the U.S. competitors.

On 17 December 1957, the Pentagon and Grumman received the following telegram from Germany:

From: USAF Military Assistance Group, Germany 12-17-57
To: Chief of Staff USAF, Wash., D.C.
Subject: Federal Republic of Germany Selection of Manned Interceptor.

MAG informed by high level FMD source that FED REP has decided to procure Grumman F11F-1F aircraft. Official announcement expected by

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Top, F11F-1F, BuNo 138646, with the ventral fins in the up position and a good interior view of the J79 engine. (Grumman via S. Nicolaou) Middle, side view of the ventral fins in the up position. (Grumman via S. Nicolaou) At left, view of 138646 with the ventral fins extended. They were first used on flight number 45. The small fin next to the right ventral fin is a fuel tank system vent. (Grumman via Corwin Meyer)

year end. Flight and technical evaluation of this aircraft and F-104 currently in progress by small group of Germans apparently prompted by desire to confirm F11F-1F decision and recognition of Lockheed's efforts in presentation of the F-104. The F-104 has not been flown previously by German pilots. Initial requirement of 150-200 aircraft being mentioned by GAF. Informal indications that the F11F-1F selection based on:

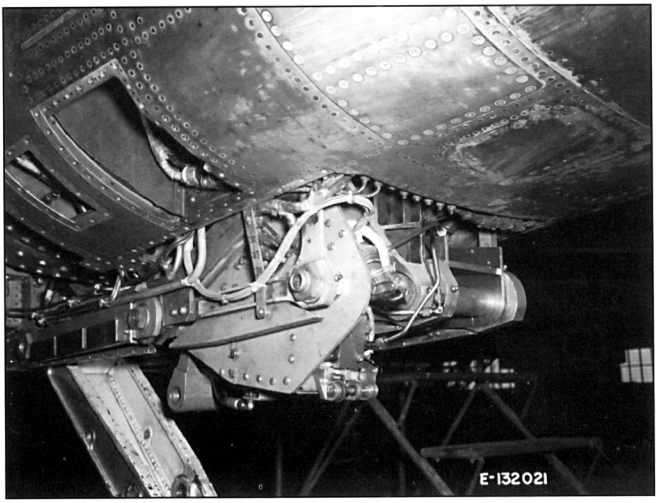
a. Short take off and landing characteristics.
b. High speed performance.
c. Adaptability of all-weather capability.
d. Cost of development to production stage having been met by the U.S.
e. Belief that aircraft can carry atomic weapon with acceptable radius of action and therefore could be used as a follow-on fighter bomber.

MAG M.E. Saunders, COL
USAF: 3785: bew

Having spent 187 days away from the plant and home during 1957, but not knowing of the telegram, I was called into the office of President Jake Swirbul and congratulated for the team's successful efforts. I was not to know until two years later what had transpired in that office an hour before he called me in.

The MAG telegram really stirred up a hornet's nest at Lockheed. They suggested that the German team should come back to visit Lockheed, fly the F-104, and compare it with the Super Tiger in order to compare the airplanes quantitatively before they made up their minds officially. The German flight test team returned in January of 1958 with LTCOL Werner and an operational pilot, Maj. Walter Krupenski, who had not been a test pilot but was a fighter pilot in WWII and had shot down 141 allied aircraft.

Both airplanes were evaluated by both pilots. COL Werner held to his original opinion but Maj. Krupinski was enamored with the greater performance of the F-104, overlooking its many unacceptable and unsafe flight characteristics. The debate went back to Germany. COL Steinhoff, who was the top pilot and head of the requirements section of the Luftwaffe, then decided to come to Edwards in order to make the final decision personally. At the end of his flight he landed the airplane at a recorded 20 feet per second rate of descent, which proved to be 110% of the design limit load of the landing gear. We wondered at the reason for this gross landing test until we found that he had a terrific toothache from the flight, and had to be rushed to the base dentist's office immediately to have a tooth pulled. He came out of the office feeling much relieved but still in an ill humor. We learned that he was very angry with us for giving him an airplane which wouldn't go over Mach 1.3, no matter how long he let it accelerate. He flew the F-104 the next day and departed for home at once. I flew the Super Tiger that same day and found that the airplane wouldn't accelerate over 1.2 Mach. We finally determined that the engine A/B nozzle was open 3 inches diameter wider than it should have been because we had been performing A/B light-off tests on prior flights to determine the highest altitude we could get it to ignite. With the A/B nozzle in that condition, the engine thrust was 2,500 pounds less than it should have been. The maintenance department had forgotten to readjust the A/B prior to Steinhoff's very critical flight. We were not to know just how critical his flight was until eight months later.



Above, ventral folding fins mechanism during installation on the first Super Tiger. (via Craig Kaston)

I went back immediately to Germany, but Steinhoff would not allow me to present the data to him describing our error in maintenance. He was an operational person, and our maintenance problem was of no interest to him. I sent him the engineering data and offered to pay for his trip back to Edwards to re-evaluate the Super Tiger. He sent me a note of thanks, but declined the offer. I gave many more German-requested presentations after that on procurement, manufacturing and future development of external stores under the auspices of Herr Fenner Achenbach, who had just been designated by the Minister of Defense as our agent in Germany. From his position he could open many doors, but not Steinhoff's. He also informed us that the final decision had not been made and that we should stay in the race. LTCOL Werner remained our champion for the Super Tiger and

also gave us continuing encouragement as the months dragged on. On 24 October 1958, the German Federal Ministry of Defense issued the following press release:

"With regard to the decision of the Interceptor-Fighter, the American Starfighter has a *slight* merit over the Grumman Super Tiger . . . The French Mirage IIIA does not fulfill our tactical requirements."

The Grumman Super Tiger was given such a close position to the F-104 so that the German procurement personnel would have a big club to hold in the forthcoming contractural negotiations with Lockheed. The contest was over.

TWO HIGH LEVEL BUT VERY BELATED COMPLIMENTS:

In September 1959, as we were leaving after our Grumman Super Tiger team had given a TFX presentation to the USAF Tactical Air Command at Langley Air Force Base, I spied the departing Lockheed TFX team. Phil Coleman, who had been the director of Lockheed's F-104 German sales team, was in the group. He introduced me to Dan Haughton, who was the President of Lockheed and Cortland Gross, the Chairman of the Board. Dan said, "I've been wanting to meet you. You single-handedly kept us from winning the German competition for one whole year, damn you!" A flattering but belated compliment from a tough competitor. I asked him if he would send a letter to the President of Grumman to verify my many expense accounts. Sorry to say, he never did. Lockheed knew a lot of "ropes" about foreign sales that my team learned the hard way. Some of these ropes hung Dan Haughton and Cortland Gross several years later after a long, public, and embarrassing foreign sales pay-off scandal perpetrated during the F-104 program in three countries.

The inexperienced German Air Force of the day had a much higher accident rate with the F-104 than the USAF. Over 100 Starfighters and pilots, including the son of the Minister of Defense, were lost in training and operational flights until General Steinhoff grounded the 770 F-104s during the months of December 1966 and January 1967. He then changed the entire training and operational syllabus to much higher safety standards. In 1960, he came to the United States to be Chief NATO Liaison Officer in Washington. Out-of-the-blue, he called me to have lunch with him on my next trip to Washington. During lunch he made a confession to me that the worst decision he ever made in his life was the selection of the Starfighter over the Super Tiger. He then elaborated. He said he was very sorry that he didn't listen to the many warnings he received from Grumman concerning the problems that would occur with the introduction of the Starfighter to his aggressive but neophyte Luftwaffe. A satisfying but belated compliment.

Of course, I had to tell Jake Swirbul about General Steinhoff's compliment, even though it was long after the demise of the Super Tiger. During our conversation, he opened up and related that after the 17 December 1957 telegram about the German selection of the Super Tiger, he and Mr. Grumman had told the Navy that Grumman would absolutely not accept a German contract. He said that they had made the call to the Navy because the competitions for the A2F Intruder, E-2C Hawkeye, OV-1 Mohawk and 400 F9F-8T Cougar Trainers were still to be decided by the Navy, and that a contract with Germany might make Grumman look too fat for Navy decision makers. They were certainly correct, we won all four of the contracts later that month. Forty years later, the Intruder and Hawkeyes were still in Navy service. Their decision was a harsh one for the Super Tiger team, but a great one for Grumman. I then asked him why he permitted us to continue for another year with the German competition. He answered me very quietly, saying, "We knew that you couldn't get that kind of experience for Grumman's future anywhere else in the world." He was right, as I was to find out shortly.

Above, the second German team came en masse, first to Grumman Bethpage, to meet Grumman management and see a demonstration by Ralph Donnell who is third from the right. They then went to Edwards AFB to see Col. Werner fly the Super Tiger. (Corwin Meyer)

THE FRENCH DIS-CONNECTION:

During my thirty-nine European trips, I visited France in early 1958 to see if they had any interest in the Super Tiger. I knew that Dassault and other French companies had good fighters, but I did not want to leave any stone unturned. Col. Gordon Duncan of ARDC suggested that I get to know Maj. Jean Franchi, the very experienced chief test pilot of the French Air Force. He would know of any potential French interest better than any of the contractors. He spoke excellent English, and suggested that he could only determine French interest if he could fly the Super Tiger. On

my next trip to Grumman I started putting a clearance through for him to fly the airplane. George Titterton, Vice President of Production, disagreed with my decision, stating that the Japanese had informally decided to purchase the Super Tiger and he didn't think we should have anybody else fly it and possibly damage it. Since we had no contract in hand, I suggested that we take it to Jake Swirbul for a final decision. Jake agreed with me and Maj. Franchi flew it on 23 June 1958. His first flight went well, but on the second flight he pulled the flaps up at 140 knots, 25 knots below minimum flight retraction speed and he settled back on the runway, skidding to a stop. The airplane slammed down so hard that he broke his back and damaged the aircraft beyond repair. Fortunately, he was flying the first prototype which was the slower of the two airplanes. But he reduced our inventory by 50%.

I was back selling in Germany at the time. At 3:00 AM I was awakened by a telephone call telling me of the news. The caller also said that Jake Swirbul wanted me to come home immediately. I certainly knew why, and I was prepared to be fired. After a 24-hour, five stop, sleepless flight home, I arrived in Jake's office in pretty bad shape. He at once said we should go to Mr. Grumman's office. I remember wondering why he couldn't fire me without Mr. Grumman's attendence at my funeral. Mr. Grumman made a very short speech. He said that he was sorry about the crash, and that he was glad the pilot was not killed. He then said that if I made 51% of my decisions correctly I would be way ahead of anybody else in the company. It was obvious that the conversation was completed; so Jake and I went silently back to his office, wherein he said that I should now get back to work. That was the last I ever heard on that subject. This reaffirmed that I worked for two fabulous leaders.

ENGLAND, ON PRECISELY THE WRONG DAY:

In 1955, I had made a two-week trip to visit the entire British aviation industry. I ended up staying at the Empire Test Pilot's School while visiting the big Society of British Aircraft Constructor's yearly air show. I was escorted on this trip by RAF Wing Commander Ivor D. "Tich" Crozier. He knew everybody in the industry and they all knew him very well!

In late 1957, I asked him to set up a date for me to give a Super Tiger presentation to the Deputy Minister of Defense in London, which he did promptly. I hadn't picked a very good time, as I soon found out. The Minister of Defense was very kind, and suggested that my presentation would probably be superfluous because of a relevant DEFENCE WHITE PAPER that had just been released that day. I did not know the importance of a White Paper, but I was soon to find out. After he showed it to me, I realized that my visit was not going to produce Super Tiger business. The White Paper stated that a major down-sizing of the entire British defense establishment was going to start as part of a massive governmental fiscal belt-tightening. The depth of the cuts would reduce their aircraft industry from ten firms to two. It would presage what was going to follow throughout the entire free world. It took a long time for the message to reach America, but it did in the early '90s. It will no doubt continue until only two major aircraft firms exist here, too. I did get a chance to visit the Tower of London before I left that afternoon, so the trip was not a total loss.

Above, group shot of the Swiss team leaders at Grumman Bethpage on Thanksgiving Day, 27 November 1958, just before coming to the author's home for dinner. On this day, they had done a splendid job during a gunnery and rocket firing test in a production Tiger. Left to right Corwin Meyer, Swiss Director of Aircraft Design Richard Greinacher; Gen. Oskar Keller, team leader; Col. Willi Frei, Chief Test Pilot of the Swiss Air Force; Gen. Othmar Bloetzer, Chief of the Swiss Air Force; Gordon Ochenrider, Grumman's Director of Super Tiger European Sales. (Corwin Meyer)

SWITZERLAND'S TINY BUT POWERFUL AIR FORCE:

During my first talks with a Swiss Air Force officer, I asked a very naive, undiplomatic but revealing question. I asked just why such a nation of long-standing neutrality like Switzerland needed an air force. He stated that his country had an army, navy and air force so that every nation in the world knew that the entire nation, to a man, fully intended to stay neutral. Now that my education was complete, I asked him to tell me about the "Swiss Navy". He told me that they had a Rhine river fleet of very fast and

deadly patrol boats. I had a much greater understanding of the Swiss freedom-loving mentality instantly.

I soon discovered that the Swiss have had a continuous and meaningful air force since 1913. They had a fleet of the latest Me. 109s during WWII which had shot down 42 German trespassers without losing a pilot. They also had the first post-WWII all-jet air force in Europe, which consisted of 21 squadrons of DeHavilland Vampires. I had a chance to visit their mountain airfield and could visually understand their need for aircraft with very short take-off and landing qualities. He also told me that their mobilization time was just seventeen minutes. It was easy to see how the Swiss have maintained their neutrality when other neutrals like Belgium and Holland couldn't, both in WWI and WWII.

At that time, the Swiss had a government factory designing and building the P-16, a straight wing, subsonic fighter which was then in the early development stages. Between March and June of 1958, their two prototypes crashed and the project was cancelled. This was the reason for their investigation into procuring a more modern supersonic fighter.

The first Swiss team came to Edwards on 24 October 1957, right after their visit to Chance Vought in Dallas, where their team evaluated the F8U-1. We had heard that Col. Frei, their 56-year-old test pilot, had performed an intentional half-loop immediately after take-off on his first flight! We were soon to find that all the Swiss pilots were that aggressive.

We found the Swiss team to be a very competent group and very knowlegable in all facets of aircraft design, manufacturing, procurement, flight test and operational skills. We were not to meet such a small but intelligently comprehensive team again in all of our sales efforts. They conducted many flights in the Super Tiger at Edwards and then visited Grumman's flight test facility at Calverton, New York. Here, they flew many live-ammunition, air-to-ground attacks in the Tiger against targets they had never seen before and in very gusty crosswinds. I was their chase pilot in another Tiger and was amazed that all of them could get 90% hits with attacks under 30° dive angle. We had never seen any other military pilots get more than 40% hits, even under superior conditions. They were professional!

I had the entire team to my home for Thanksgiving dinner. To the abject awe of all the other Swiss nationals, my wife instructed the two Generals to carve the two turkeys. That should have had a beneficial outcome on the competition, but it didn't.

We learned from them that the French Mirage IIIA was the only real competition to the Super Tiger. I made many trips to Switzerland, both from Germany and the United States, to deliver more detailed answers to them than any other country had required. During these trips it became apparent that the Mirage was going to be tough competition for Grumman to beat in the technical, cost and possible co-manufacturing areas. The Swiss have three different language-speaking sections in their small country: German, French, and Swiss-deusche. It turned out that the Minister of Defense was Chaudet, who was of French extraction and whose brother was involved in the management of Dassault, makers of the Mirage. The debate in Switzerland concerning their new fighter was fierce in all respects, but politics finally won out over the preferences of the Swiss Air Force, and the French Mirage III was finally declared the winner.

The Swiss returned twice more to Edwards in November 1958 and again in June 1959 for more flight and ground attack testing. Their new team of test pilots were still the best we had seen from any Air Force that we worked with.

CANADIAN INTEREST:

In 1958, the Canadian government, having gotten wind of the British Defense White Paper, started

Above, the Swiss authentic bronze cow bell that was presented to the Grumman Flight Test team by the Swiss delegation after the first flight evaluation at Edwards in November 1958. (Corwin Meyer)

a massive reduction in its own rather large aviation industry. Canada had been designing and building its own military aircraft, as well as building American and British aircraft for years. In 1958, the Canadians terminated the very sophisticated Avro Arrow all-weather fighter and its Orenda engine development programs. But Canada still required a modern fighter to fulfill its domestic and NATO requirements.

We solicited the Canadians on behalf of the Super Tiger, and in April Group Captain Don Laubman and Wing Commander Bob Middlemis came to Edwards and evaluated the Super Tiger during a 12-flight program. They also evaluated the F-104, as they knew that Germany had made that selection just a few months

earlier. They well understood the great cost and time savings which resulted from joining a large production program of a developed fighter. Their flight test results were as glowing as the other teams that had flown the Super Tiger. Their Evaluation Report No. S 1038-110 is quoted below.

"The F11F-1F (Super Tiger) appears to be an excellent tactical fighter.

The RCAF considers the F11F-1F as a suitable aircraft with which to replace the Sabre aircraft for the strike attack role. The F11F-1F can, with a short conversion, be safely flown by any pilot who is proficient on the (subsonic) Sabre aircraft."

In November, RCAF requirements were finalized for their NATO strike attack aircraft role. Detailed discussions began promoting many visits of Canadians to Grumman and Grumman visits to Ottawa. Two more flight evaluations were completed by other RCAF personnel, including Wing Commander Bob Christie.

The Lockheed sales team was very aggressive, and we saw them every time we visited Canada. Although the Canadians flew both airplanes and were most kind in their comments about the Super Tiger, we kept the pressure on both in Canada and at Grumman. A complete in-country production program of the Super Tiger was delivered to the competition personnel in Canada.

In May 1959, USAF General Norstad affirmed in a statement he issued in Ottawa that the RCAF NATO specification requirements listed only the Super Tiger by name.

To sweeten Grumman's chances and to prevent recurrence of the large job loss that happened when the Avro Arrow was cancelled, our contracts department inserted a last-minute provision which offered major subcontracts of other Grumman Navy airplanes at the end of the Super Tiger production program. We were told that this was our winning ace-in-the-hole. Lockheed heard about our proposal the day before the competition closed and they really topped Grumman. Lockheed proposed a major subcontract program immediately with their T-33, and other programs which lifted the present, not future, onerous aviation unemployment load off the politician's back. The Canadians wanted the Super Tiger, but their decision for the F-104 was announced on the day that the last Canadian Super Tiger flight test program was completed at Edwards. Lockheed was again teaching us international sales fundamentals much faster than we could absorb them.

Above, Canadian test pilot Jack Woodman sits in the second Super Tiger. The intake shape and bump were of the second design tried (see page 39). Note the Super Tiger's new forward canopy, which was built over the original F11F canopy. (via S. Nicolaou)

THE JAPANESE COMPETITION:

On Memorial Day weekend 1957, I received a call from my mentor, Col. Duncan of the Air Research and Development Command, telling me that the first Japanese fighter selection team was in Los Angeles visiting Northrop, North American, Lockheed and Convair. He said that Grumman was mistakenly not on the list, but General Boyd had written a letter to the USAF team leader telling him that they must include the Super Tiger on

Below, Kawasaki Aircraft Engineers visit Grumman on 25 September 1958. Left to right: Mr. Ken Endo, Structures Engineering Supervisor; Mr. Toshio Hiraki, Preliminary Designer and Aerodynamicist; Mr. Corwin Meyer; Mr. Kiyoshi Kitano, Engineering Department Superintendent; Mr. L. J. Evans, general counsel. (Corwin Meyer)

their list. Fortunately, I had a copy of that letter.

I gathered all my presentation materials, flew immediately to Los Angeles, located the team and asked to be given a time for presentation. The USAF team leader rudely said that he knew nothing of the Super Tiger being on their list, and that the Japanese team did not have any time for another presentation. My letter from General Boyd changed his mind. On Saturday of that long weekend, I started my pitch to General Minoru Genda and his team of ten experts of the Japanese Self Defense Force.

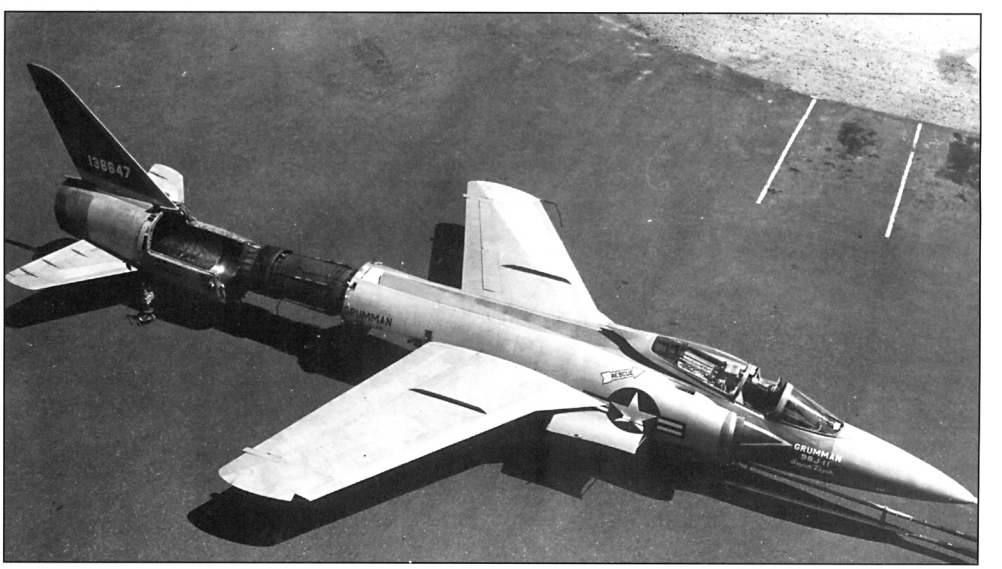
In 1941, General Genda was a Commander in the Japanese Navy who did all the aerial planning for the attack on Pearl Harbor. He and his team spoke fairly good English, but I was prepared to give the presentation in both English and Japanese, or so I thought. To present the airplane in Japanese, Grumman had hired a professional translator who worked at the United Nations. We then made two-by-three-foot presentation boards, one in English and one in Japanese, for each page of the presentation. I had just opened the first board and started my pitch when I noticed that the Japanese, while reading the Japanese side, were placing their hands over their mouths to stifle snickers. They soon burst out in embarrassed laughter. It got so raucous that I finally stopped talking. General Genda graciously bowed and asked to speak. He said very formally that his group were honored that Grumman had tried to put our presentation into their language. He continued saying that no other contractor had showed that effort and they were most appreciative, but someone had made a mistake because it was translated into Korean, not Japanese. He then observed that it was not done by a technical person because the translator had not used the English word afterburner, which the Japanese were familiar with, but had described the afterburner as "the very large fire after the small fire in the engine". He asked if our handouts were done the same way, because he said that they would dearly like to take this presentation back to Japan with them.

I then restarted the presentation and stood in front of the "Japanese" board for the rest of the program. The Japanese thanked me profusely after they were given brochures, and went back to Japan the next day.

Because the German competition was heating up, I flew back to Bonn the next day and turned over the care and feeding of the Japanese to my former boss, Herb Crawford, who had been chief of flight test. He had previously suggested that he would be interested in pursuing the Japanese arena when it started. I was most appreciative, as I had my hands full working the German, Swiss, French, English, and Canadian programs at that time.

Herb went to Japan in August when it became apparent that the Japanese were serious about the Super Tiger. Lockheed was turning out to be the real competitor, although Convair, North American and Northrop were still hanging in. His first

Below, the Super Tiger with Grumman designation 98J-11 painted on the nose as it was tested by the Japanese illustrating the fuselage and tail breaks for ease of engine removal. (via Craig Kaston)



problem was that the USAF Military Assistance Advisory Group were not about to let a Navy airplane into the competition. He returned to the states to convince ADM Heyward, Deputy Commander Naval Operations Air, to intercede. He did, and many doors opened up in Japan for Herb.

THE FIRST JAPANESE EVALUATION TEAM APPROVES THE SUPER TIGER:

The first Japanese flight test team came over to Edwards AFB in late March of 1958 and flew the competitive aircraft. They were impressed with all of the airplanes, but they mostly favored the Super Tiger.

On 13 April 1958, as a result of their evaluation, the Japan Times reported as follows:

"The National Defense Council yesterday informally approved the selection of the F11F-1F Super Tiger for the Self Defense Air Force. The Defense Council decided on an informal approval in view of the fact that various conditions, such as budgetary plans by Japan and the extent of financial assistance from the United States, still needed to be ironed out."

The specifics of that informal decision were reported in the June issue of the RAF Times as :

".....The Japanese National Defense Agency has revealed how and why it came to select the Grumman G98J-11 (Super Tiger) as the future backbone of the Japanese Self Defense Force.

Conclusions: The North American F-100D and F-100F do not offer favorable prospects as to their interception performance. The F-104A has excellent speed and climb performance,

Top, General Genda sits in the cockpit of the Super Tiger. Middle and at right, Captain Joe Jordan, USAF project pilot, checking out the second Japanese flight test team. John Norris is the person out of uniform. (via Craig Kaston and John Norris)

At left, Japanese test pilot prepares to make another Super Tiger test flight. (via Craig Kaston)

but possesses inadequate radius' of action to meet the JASDF needs, and its multi-purpose characteristics are insufficient and it possesses safety problems. The Northrop N-156F is attractive from the viewpoint of cost, and its take-off and landing characteristics are particularly suited to the JASDF requirements, but its performance needs improvement and the lead time for mass production of this type is the longest.

The G98J-11 meets the performance requirements of the JASDF, it possesses a high degree of safety, it has excellent multi-mission characteristics, and it can take off and land in relatively short distances. It will be able to fit into a wide range of duties and fits into the future pattern of Japanese air defense. Although it is not likely to be adopted into the US Navy and its cost per aircraft is more than any other type evaluated, it is the most suitable with which to replace the F-86F Sabre."

Right after the April informal announcement of the Japan Times, Japan sent a large team of Mitsubishi manufacturing and contractural personnel to Grumman to finalize a contract for the joint manufacture of 50 Super Tigers in the United States, and to complete the rest of the 400 million dollar manufacturing contract in Japan.

On 18 June 1958, Jake Swirbul, President of Grumman, sent the following telegram to the Honorable Neil McElroy, US Secretary of Defense:

"We are pleased to advise you that mutually acceptable detailed production plans and technical agreements have been completed with Mitsubishi Heavy Industries to manufacture our Super Tiger, which was selected by the Japanese government for production in Japan. A Mitsubishi team, officially sent to our plant by the Japanese government and headed by Mr. Nakagawa, senior advisor to the president, and Mr. Yui, manager of the aircraft division, had spent a month in our plant securing manufacturing data to produce the Super Tiger in Japan. We assure you that we have done all that we can to maintain cooperative Japan-U.S. relations, realizing the importance our country attaches to these relations."

As a major subcontractor to Mitsubishi, Kawasaki Aircraft subsequently sent a team to Grumman to have the same review.

As Lockheed had previous contracts in Japan to manufacture the P2V Neptune, they knew all the ropes of the military structure and the JSDF heirarchy. They also knew how to get continous publicity in the Japanese news media. We were up against the first team of international sales in the last big international fighter competition. Lockheed put their best guns and their most experienced subterfuge experts against us. It takes a very strong effort in any country to have the government overturn a premier-level public decision of many prior, positive public announcements. Lockheed knew exactly how this was to be accomplished. All the tricks of a James Bond epic were used by these experts.

Even though Prime Minister Kiishi had announced the decision, it still had to be approved by the Japanese Self Defense Forces and Minister of International Trade and Industry, a wiley Mr. Kono.

THE SECOND FLIGHT EVALUATION TEAM DISAPPROVES:

The second Japanese evaluation team came to Edwards AFB on 1 September 1959, and was headed by General Genda. Prior to their coming, they had requested that the USAF perform some critical tests on the Super Tiger to obtain specific information for them. This five-flight evaluation was headed by Captain Joseph R. Jordan, and was flown interspersed with the Japanese team flights.

Grumman had installed a newer Phase I GE J79-7 engine and afterburner nozzle in the Super Tiger. In order to fit space limitations of the fuselage, a -3A afterburner needed to be installed. This engine change increased the afterburner thrust from 15,000 to 15,600 pounds of thrust, and gave much better fuel specifics over the entire flight envelope.

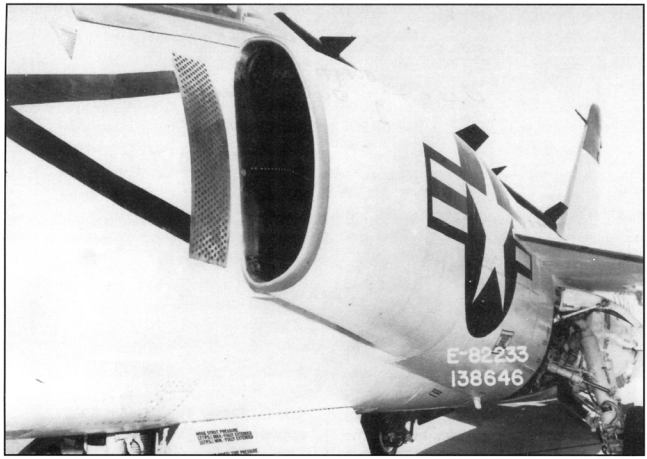
The flight limitations of the aircraft had been expanded from 550 knots to 725 knots at all altitudes, and the maximum Mach number was expanded to Mach 2 at 35,000 feet and above and proportionally reduced to Mach 1.14 at 5,000 feet. This was a very large envelope expansion since their first evaluation.

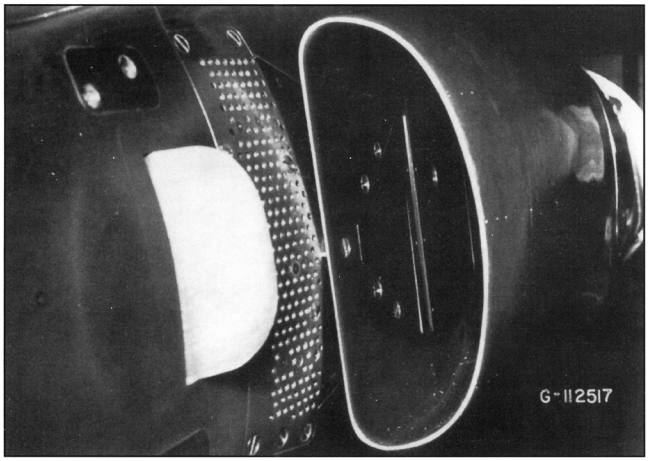
The USAF flight test conclusions in their Addendum No. 1 to AFFTC-TR-56-36 December 1959 were as follows:

"Specific Range was increased by 21.6%

Supersonic acceleration from 1.1 Mach to 1.6 Mach was decreased from 3.5 minutes to 2.6 minutes.

Better supersonic manuevering capability.





At left and at left middle, revised intake duct design used on BuNo 138646. It incorporates an enlarged ovoid intake with a boundary layer bump and bleed-air holes fitted forward of the intake. The top photo was taken on the 45th flight. (Grumman)

The subsonic aerobatic manuevering characteristics are excellent in both military and afterburner power. F-86 speeds can be used for any manuever entries.

The airplane is directionally stable and does not need a yaw damper except in rough air."

We felt this was a great report, but realized the F-104 also had the -7 engine. Even with this information in hand, the second Japanese team was overly impressed by the performance of the F-104, even though it did not have the 200 nautical mile intercepter mission range that had been a firm JASDF requirement. They certainly did not go back to Japan with the Super Tiger ferver of the first JASDF team.

When the team returned to Japan, it took several weeks for their report to be edited. The report stated that the F-104 was the superior airplane, and the decision to purchase and manufacture the Super Tiger should be rescinded. All of the reasons of the first selection, such as shorter take-off and landing, safety, greater multi-mission capability and range, were forgotten.

A public meeting was called by the Prime Minister in late October and the final selection of the Lockheed F-104 was announced. Grumman went home knowing that there was a lot to learn about international selling and that Lockheed's sales team was vastly superior to Grumman's. Grumman sold the meat, Lockheed sold the sizzle.

At left, final enlarged intake design and boundary layer bump as installed on BuNo 138647. A second set of bleed-air holes was added to the interior of the intake. (Grumman)

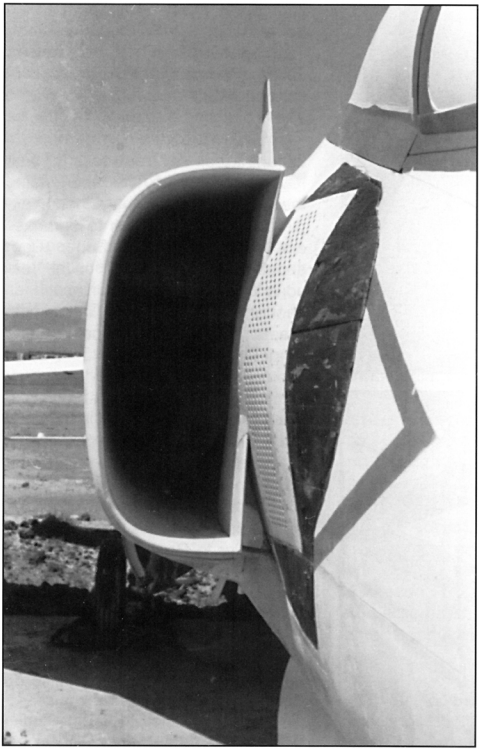
Their squadron accident rate was not as bad as the German indoctrination. But with over 50 Japanese F-104s lost operationally in the first two years, it was bad enough that many newspapers ran articles which questioned the decision to cancel the Super Tiger in favor of the F-104. It was nice news for us to read, but put no money in our pockets.

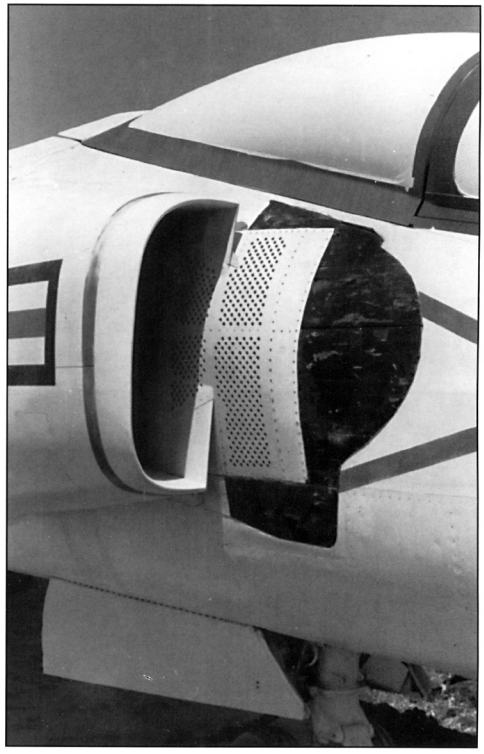
Between May 1956 and October 1959, the two Super Tiger aircraft were flown by a total of 58 military and civilian test pilots representing seven air forces of the United States, Germany, Switzerland, Canada, Japan, France, and England.

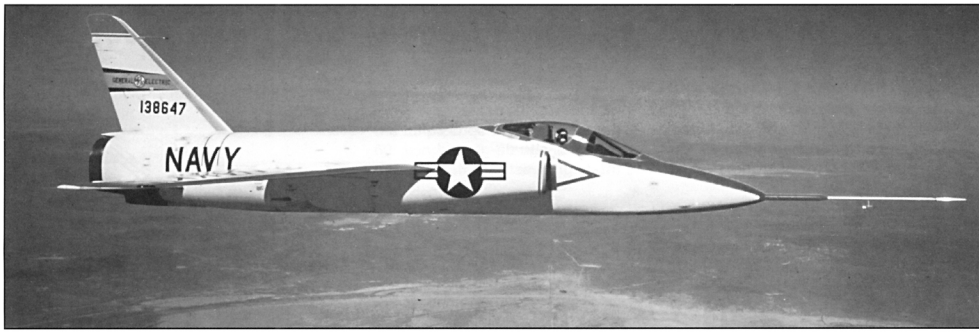
Grumman had hit home runs in the first inning in four countries technically, but lost politically at the end of the ninth inning in each game. We were simply "old too soon and smart too late."

Above, Super Tiger BuNo 138647 as it appeared in 1985 at NAS China Lake, California. The GE J79 XF4D-1 Skyray is parked in the background. Note the Sidewinder missile rail attached to the outer wing pylon. (Ginter)

Below, two views of the final intake and boundary layer intake bump. The bump was constructed of wood and its protective coating has worn away leaving the black area shown in the photos. (Craig Kaston)







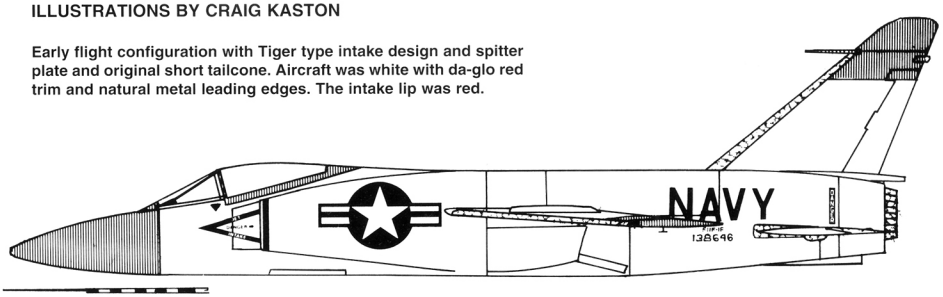
GENERAL ELECTRIC BAILMENT

The number two Super Tiger, BuNo 1138647, was bailed to General Electric during its test life, and is seen here with GE markings on the tail. The aircraft was white with red trim and black lettering. The GE markings were yellow with black lettering and borders. Note the 60° wing root fillets. The nose boom had to be two fuselage widths ahead of the nose in order to keep the airspeed system unaffected from the shock wave generated by the nose of the airplane. The little vane hanging below the boom is a yaw vane.

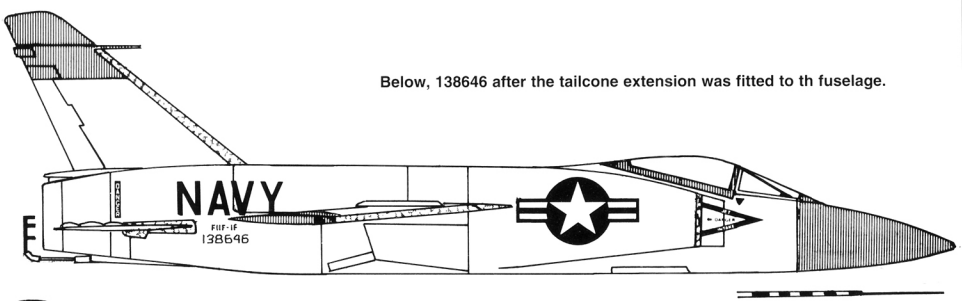
F11F-1F SUPER TIGER, Aircraft Number One BuNo 138646

ILLUSTRATIONS BY CRAIG KASTON

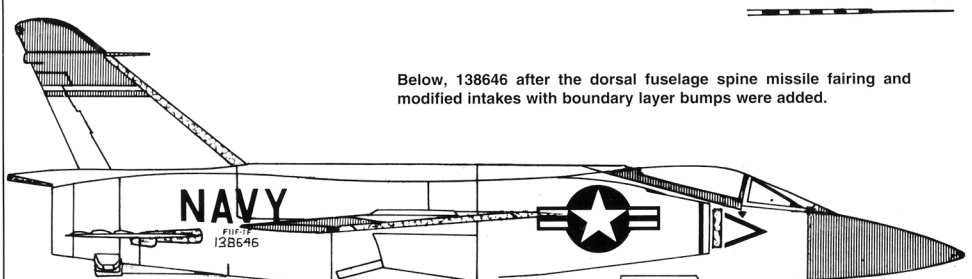
Early flight configuration with Tiger type intake design and spitter plate and original short tailcone. Aircraft was white with da-glo red trim and natural metal leading edges. The intake lip was red.



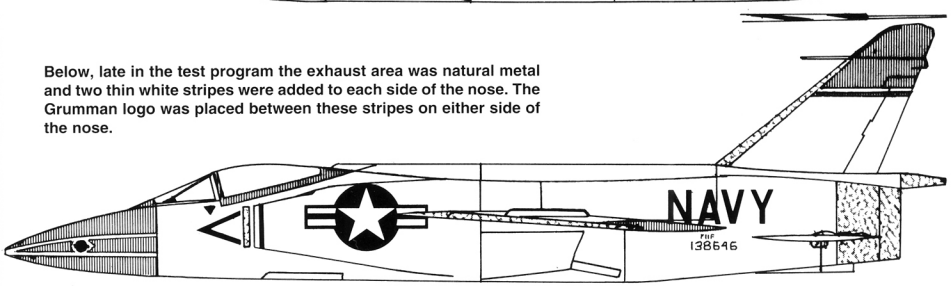
Below, 138646 after the tailcone extension was fitted to th fuselage.



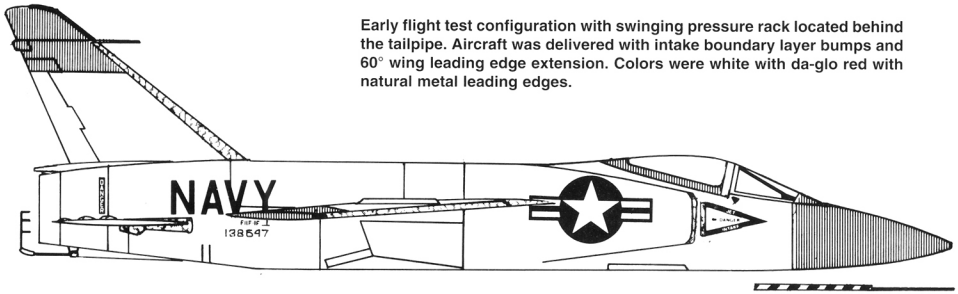
Below, 138646 after the dorsal fuselage spine missile fairing and modified intakes with boundary layer bumps were added.



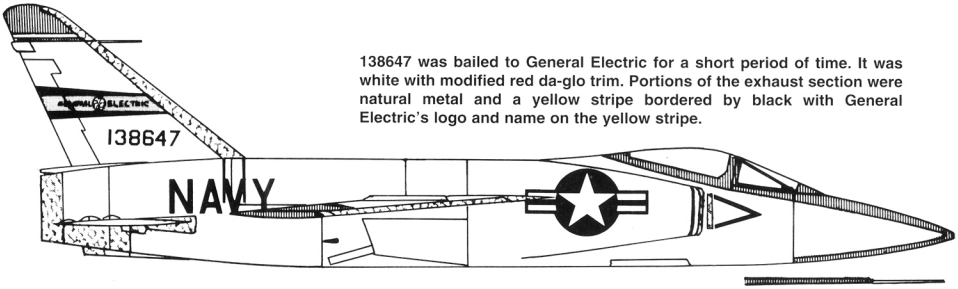
Below, late in the test program the exhaust area was natural metal and two thin white stripes were added to each side of the nose. The Grumman logo was placed between these stripes on either side of the nose.



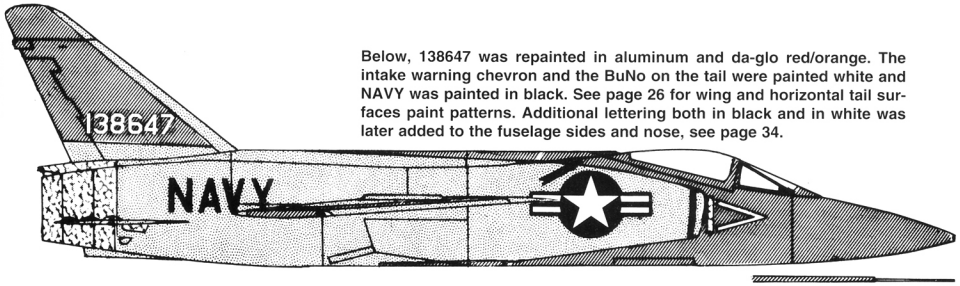
F11F-1F SUPER TIGER, Aircraft Number Two BuNo 138647



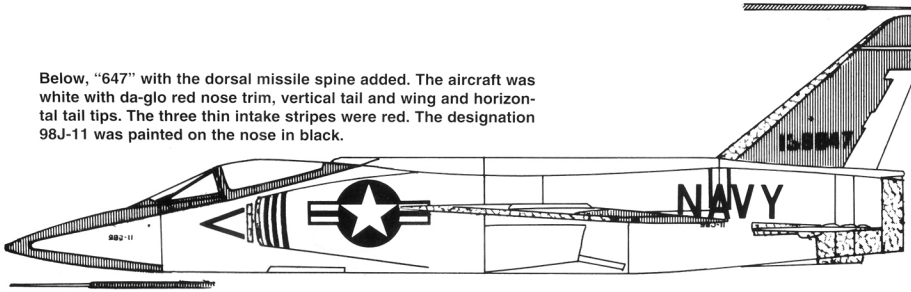
Early flight test configuration with swinging pressure rack located behind the tailpipe. Aircraft was delivered with intake boundary layer bumps and 60° wing leading edge extension. Colors were white with da-glo red with natural metal leading edges.



138647 was bailed to General Electric for a short period of time. It was white with modified red da-glo trim. Portions of the exhaust section were natural metal and a yellow stripe bordered by black with General Electric's logo and name on the yellow stripe.



Below, 138647 was repainted in aluminum and da-glo red/orange. The intake warning chevron and the BuNo on the tail were painted white and NAVY was painted in black. See page 26 for wing and horizontal tail surfaces paint patterns. Additional lettering both in black and in white was later added to the fuselage sides and nose, see page 34.

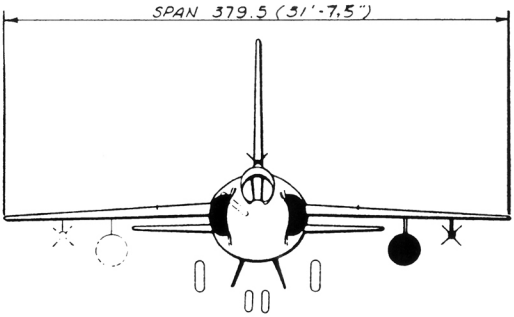


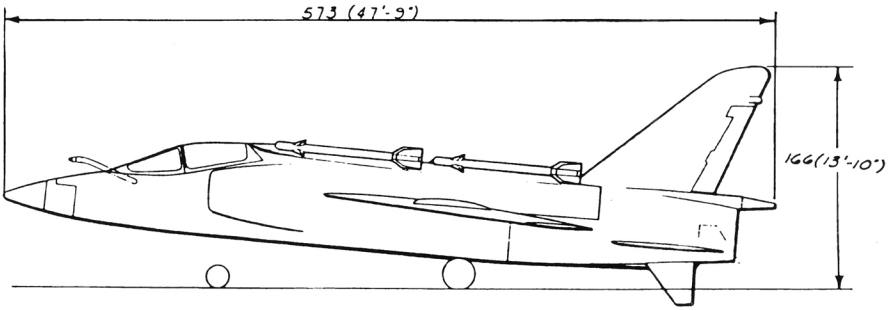
Below, "647" with the dorsal missile spine added. The aircraft was white with da-glo red nose trim, vertical tail and wing and horizontal tail tips. The three thin intake stripes were red. The designation 98J-11 was painted on the nose in black.

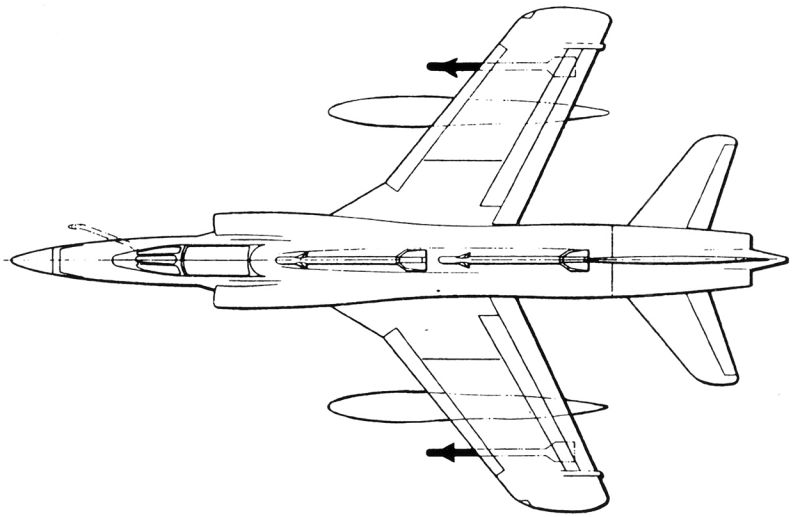
GRUMMAN SUPER TIGER DESIGN 98J-1

ORIGINAL GRUMMAN SUPER TIGER PROPOSALS INCLUDED USAGE OF FOLDING VENTRAL FINS FOR ADDED STABILITY AT-OR-NEAR MACH 2.0. EARLY FLIGHT TESTING PROVED THAT THE FINS WERE NOT NEEDED.

Gross Weight	22,728 lb.
Internal Fuel	8,148 lb.
Wing Area	250 sq.ft.
Engine - Phase I	J79-GE-3
Engine Rating (SSL)	15,000 lb.





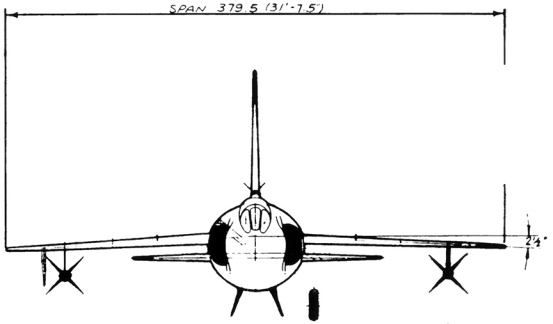


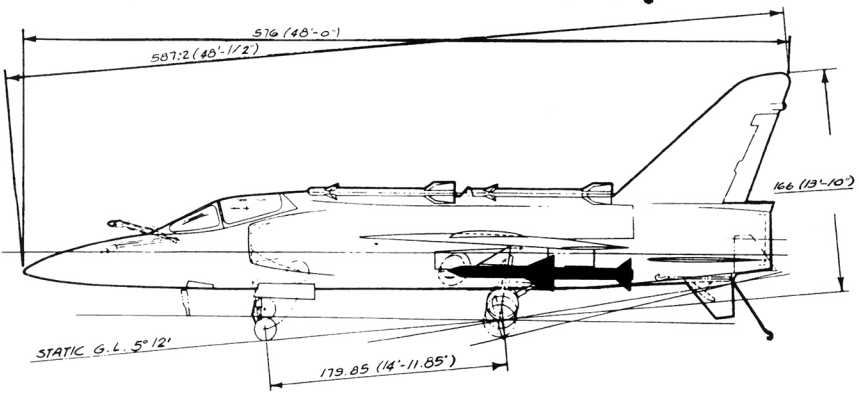
NOT TO SCALE

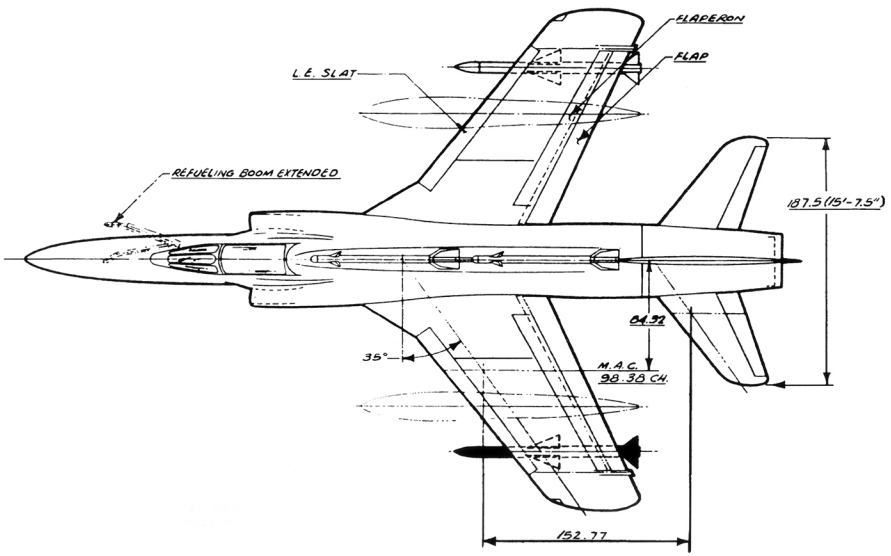
GRUMMAN SUPER TIGER DESIGN 98J-2

ALL-WEATHER SPARROW EQUIPPED VERSION.

Takeoff Gross Weight with 2 Sparrows, 2 Sidewinders and 2-150 gal. drop tanks	27,807 lb.
Total Fuel	10,111 lb.
Wing Area	250 sq. ft.
Engine-Phase I	J79-GE-3



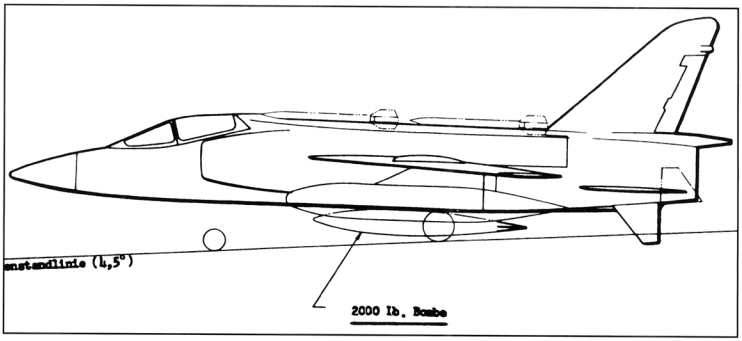




DESIGN 98J-5 AS TESTED AND FLOWN FOR FOREIGN BUYERS

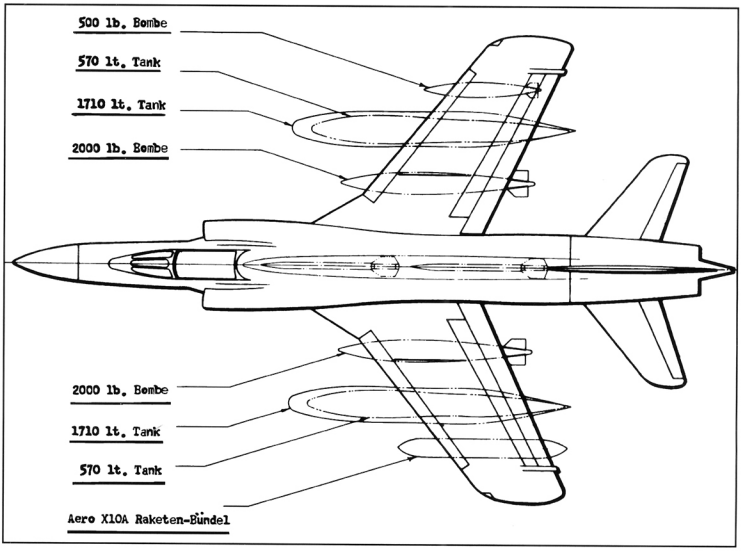
ARMAMENT SYSTEM:

Primary armament consisted of two Sidewinder missiles mounted on the top of the fuselage between the canopy and the fin. Additional missiles could be carried on the wing pylons. Alternate armament could consist of four 20mm guns mounted in the fuselage, with an ammunition load of 125 rounds per gun. In addition to either or both of the above, a total of 7 external store stations were provided. Maximum external useful load was in excess of 9,000 pounds. The fire control equipment was to have been an APQ-50 type radar with air-to-air and air-to-ground capabilities.



FUEL LOAD:

Internal fuel load was 7,836 pounds (6,648 pounds for 20mm gun configuration). 1,548 pounds were located in the wing and fin fuel tanks. The balance was carried in bladders and integral fuselage cells ahead of and under the engine. On internal fuel, ferry range was 1,100 nautical miles (860 with guns). With two external 150 gallon drop tanks, ferry range was 1,400 nautical miles (1,160 with guns).



PERFORMANCE SUMMARY:

Take-off Weight
23,245 lbs.

Fuel JP-4 7,836 lbs.

Combat Weight 20,111 lbs.
Landing Weight 16,409 lbs.

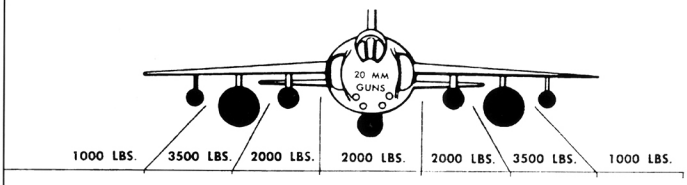
Wing Loading T.O. 92.9 lbs.
Wing Loading Combat 80.4 lbs.

V/Max @ 35,000 ft. 1.89 Mach
V/Max @ 40,000 ft. 2.04 Mach
V/Max @ 45,000 ft. 1.78 Mach
(Combat Weight with Armament)

Maximum Energy Altitude
70,000 + ft.

Min. Time to 65,000 ft. 9.5 min.

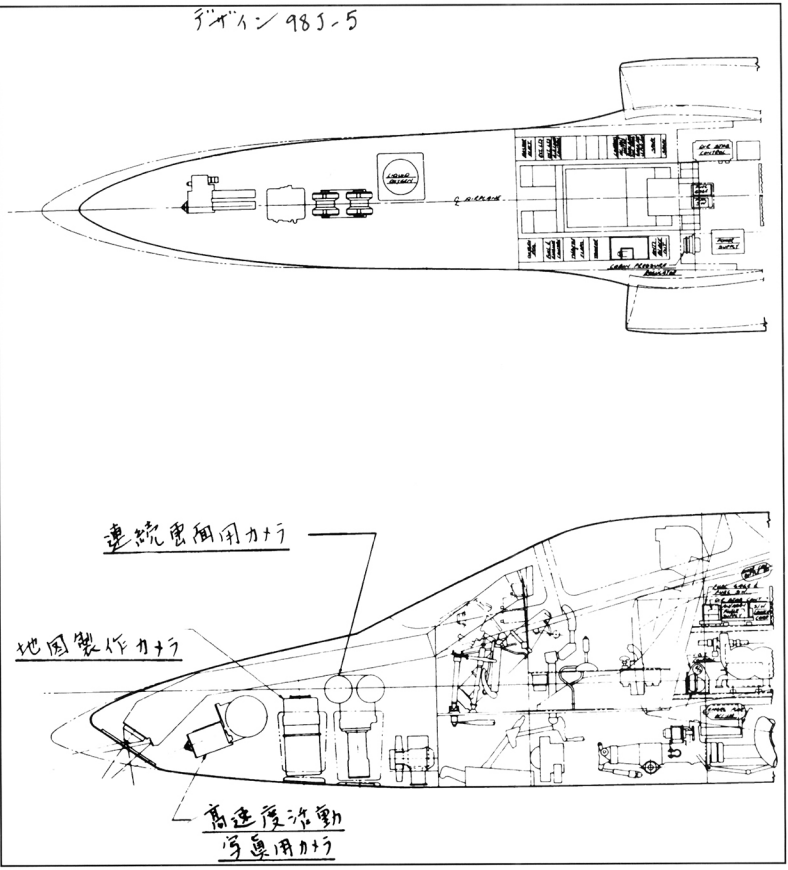
MAXIMUM PYLON WEIGHT FOR EACH OF THE SEVEN STORES STATIONS
Maximum external load in excess of 9,000 pounds.



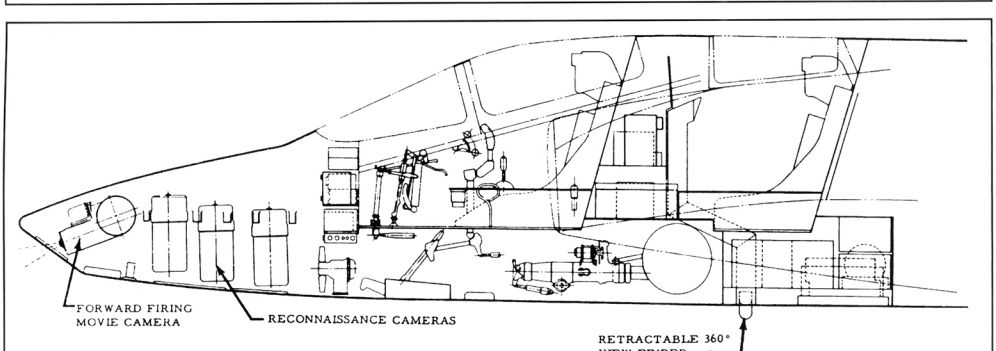
DESIGN 98J-5 PROPOSED PHOTO-RECON VERSION

Design 98J-5 as test flown by potential foreign buyers was also offered as a dedicated high speed Mach 2. photo-reconnaissance aircraft. A complete photographic suite could be installed in a shorter modified nose with four camera positions and eight camera windows.

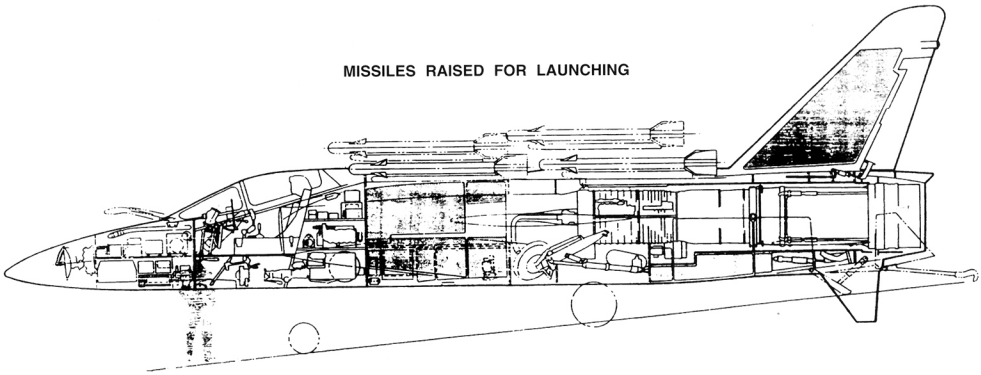
Below, Design 98J-7 was offered as a two-seat photo-reconnaissance aircraft. It differed from the Design 98J-5 in having an additional camera position.



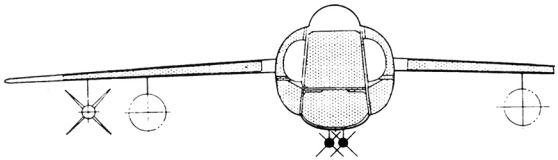
DESIGN 98J-7 PROPOSED TWO-SEAT PHOTO-RECON VERSION

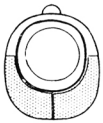


FUSELAGE GENERAL ARRANGEMENT DESIGN 98J-5



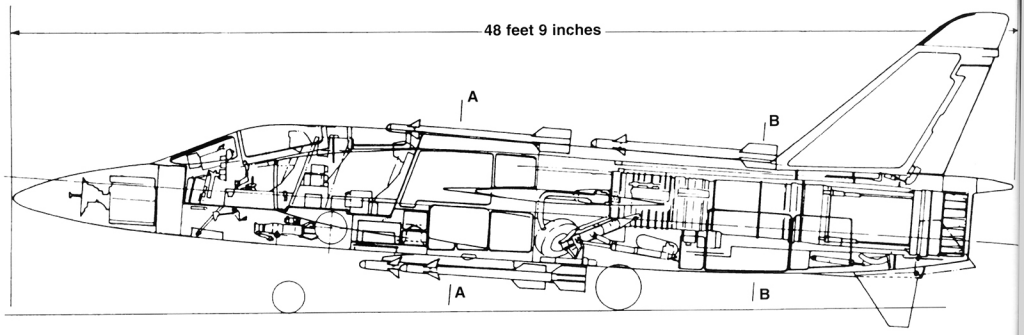
GENERAL ARRANGEMENT DESIGN 98J-7 2-SEAT ALL-WEATHER FIGHTER

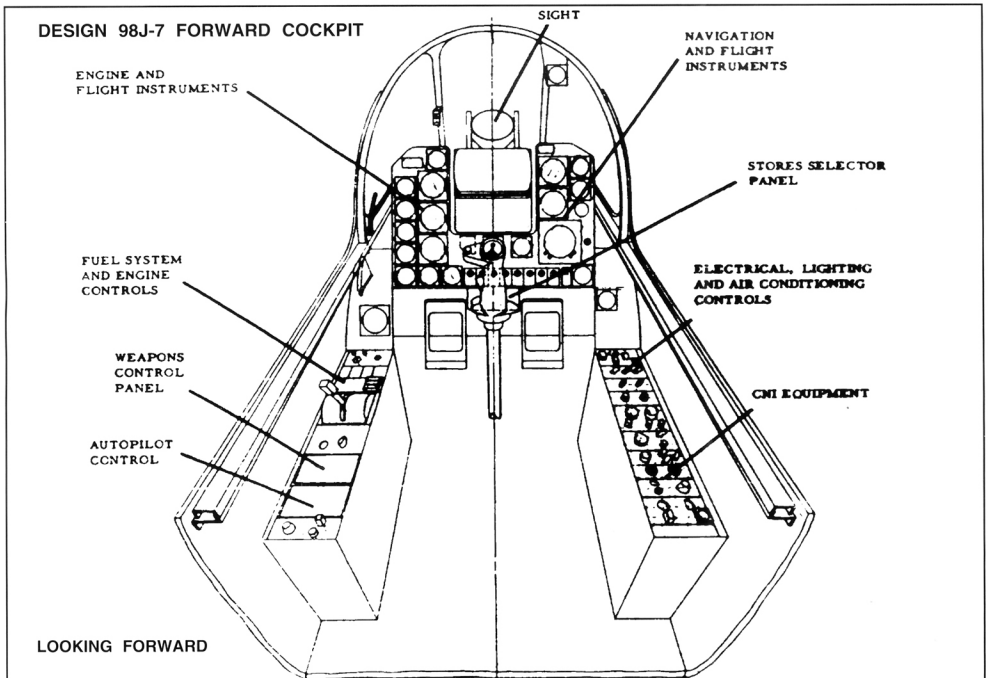


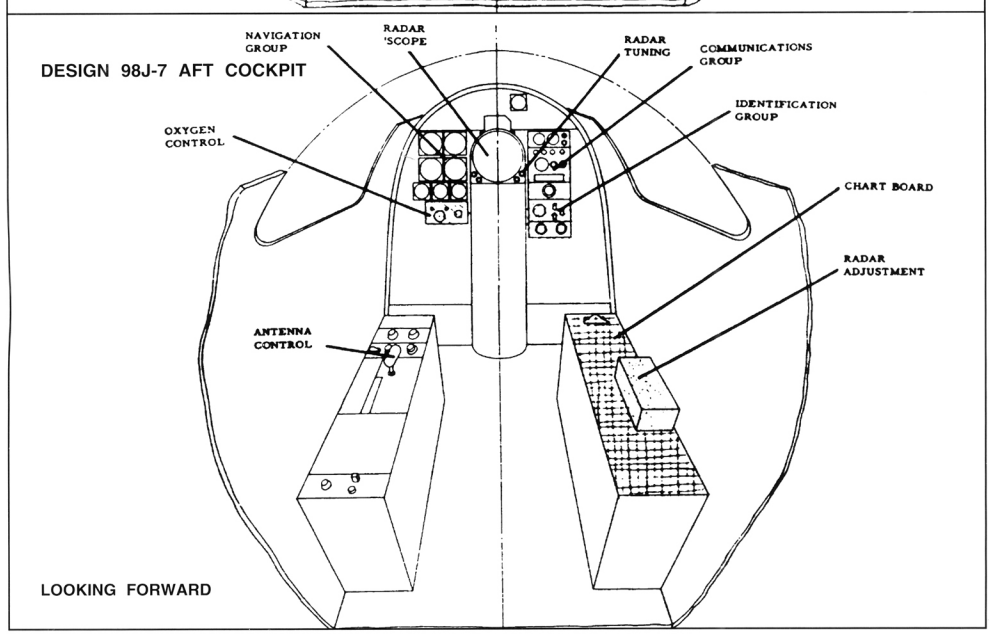


The two-seat Super Tiger was to have had a Radar Intercept Officer in the aft seat, much like the McDonnell F-4 Phantom. Maximum armament was to have been four Sidewinders and four Sparrows.

Gross weight	23,346 lb.
Internal fuel	7,310 lb.
Wing area	250 sq.ft.
Engine	Phase I-J79-GE-3
Engine Rating (SSL)	15,000 lb.



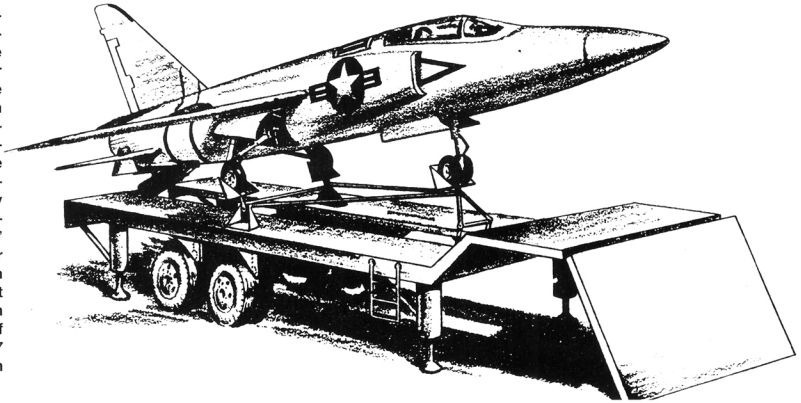

DESIGN 98J-7 FORWARD COCKPIT
SIGHT
NAVIGATION AND FLIGHT INSTRUMENTS
ENGINE AND FLIGHT INSTRUMENTS
STORES SELECTOR PANEL
FUEL SYSTEM AND ENGINE CONTROLS
ELECTRICAL, LIGHTING AND AIR CONDITIONING CONTROLS
WEAPONS CONTROL PANEL
CNI EQUIPMENT
AUTOPILOT CONTROL
LOOKING FORWARD

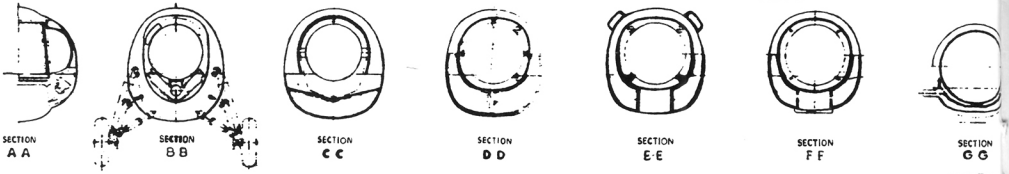

DESIGN 98J-7 AFT COCKPIT
NAVIGATION GROUP
RADAR 'SCOPE
RADAR TUNING
COMMUNICATIONS GROUP
IDENTIFICATION GROUP
OXYGEN CONTROL
CHART BOARD
RADAR ADJUSTMENT
ANTENNA CONTROL
LOOKING FORWARD

SUPER TIGER'S PROPOSED ZERO LENGTH MOBILE ROCKET LAUNCHER

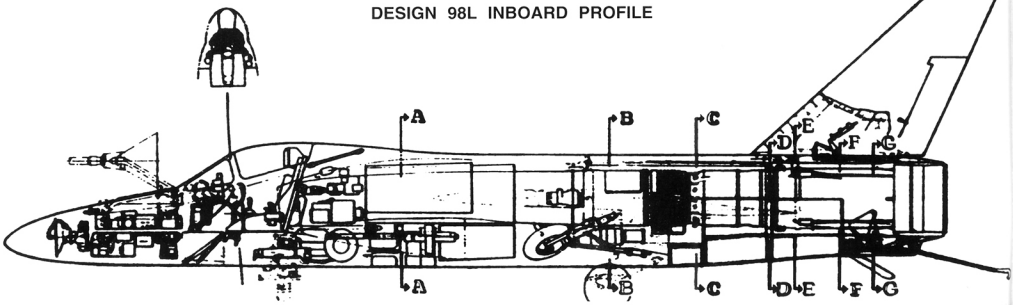
The Super Tigers compact size, excellent slow-speed flight characteristics and thrust to weight ratio, allowed Grumman to market the fighter as a mobile point defense aircraft. This concept was tested by the USAF on several different aircraft including the North American F-100 Super Sabre. However, the Super Tiger would have been a much better candidate because it's structure was some 70% stronger than USAF Century series fighters. This due to U.S. Navy carrier aircraft design specifications.

Above, a production Tiger demonstrates the ease at which a Super Tiger could have been mounted on a flatbed launching trailer. Grumman provided the aircraft and trailer for a Teddy Roosevelt 'Centennial Year' parade in Oyster Bay. (via Don Spering / AIR) At right, Grumman illustration of design 98J-7 ready to launch from it's trailer.

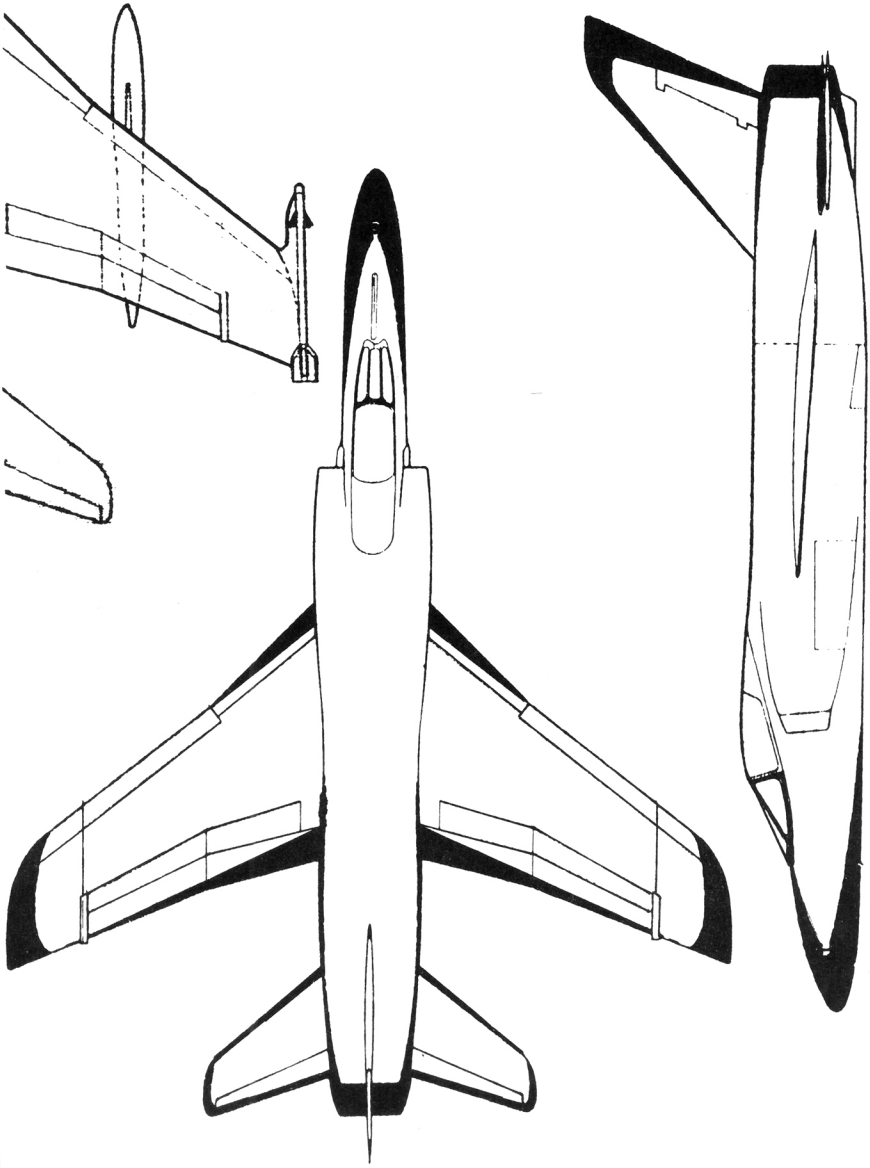




DESIGN 98L INBOARD PROFILE



SUPER TIGER DESIGN 98L COMPARISON TO THE PROTOTYPE F11F

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